EXHIBIT A

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
13/971,606	8836922	3645	9200

OC000000081319481

Correspondence Address/Fee Address Change

The following fields have been set to Customer Number 138779 on 03/09/2016

- **Correspondence Address**
- **Maintenance Fee Address**

The address of record for Customer Number 138779 is:

138779
McDonnell Boehnen Hulbert & Berghoff LLP/X
300 South Wacker Drive
Chicago, IL 60606

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/971,606	09/16/2014	8836922	13-873	4985

98929 7590 08/27/2014

McDonnell Boehnen Hulbert & Berghoff
LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Google Inc., Mountain View, CA, Assignee (with 37 CFR 1.172 Interest);
Gaetan Pennecot, San Francisco, CA;
Pierre-Yves Droz, Los Altos, CA;
Drew Eugene Ulrich, San Francisco, CA;
Daniel Gruver, San Francisco, CA;
Zachary Morriss, San Francisco, CA;
Anthony Levandowski, Berkeley, CA;

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

98929
McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/971,606	08/20/2013	Gaetan Pennecot	13-873	4985

TITLE OF INVENTION:

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
Nonprovisional	NO	$960	$0	$0	$960	09/16/2014

EXAMINER	ART UNIT	CLASS-SUBCLASS

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 McDonnell Boehnen Hulbert & Berghoff LLP

2

3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Google Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Mountain View, CA

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ■ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☑ Issue Fee

☐ Publication Fee (No small entity discount permitted)

☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

☐ A check is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 13-2490 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /Richard A. Machonkin/ Date August 12, 2014

Typed or printed name Richard A. Machonkin Registration No. 41,962

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	13971606
Filing Date:	20-Aug-2013
Title of Invention:	DEVICES AND METHODS FOR A ROTATING LIDAR PLATFORM WITH A SHARED TRANSMIT/RECEIVE PATH
First Named Inventor/Applicant Name:	Gaetan Pennecot
Filer:	Richard A Machonkin
Attorney Docket Number:	13-873

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt

EFS ID:	19840411
Application Number:	13971606
International Application Number:	
Confirmation Number:	4985
Title of Invention:	DEVICES AND METHODS FOR A ROTATING LIDAR PLATFORM WITH A SHARED TRANSMIT/RECEIVE PATH
First Named Inventor/Applicant Name:	Gaetan Pennecot
Customer Number:	98929
Filer:	Richard A Machonkin
Filer Authorized By:	
Attorney Docket Number:	13-873
Receipt Date:	12-AUG-2014
Filing Date:	20-AUG-2013
Time Stamp:	12:59:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$960
RAM confirmation Number	10094
Deposit Account	132490
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	13-873_Issue_Fee.pdf	73973 352509f977a704ae24707e974e0195b0ab2acd7b	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30336 8f620447ba19e239430e680173d1c808e7c1bd89	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	104309		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/971,606	08/20/2013	Gaetan Pennecot	13-873

CONFIRMATION NO. 4985

98929
McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

NONPUBLICATION RESCISSION LETTER

OC000000069858860

Date Mailed: 07/29/2014

Communication Regarding Rescission Of Nonpublication Request and/or Notice of Foreign Filing

Applicant's rescission of the previously-filed nonpublication request and/or notice of foreign filing is acknowledged. The paper has been reflected in the Patent and Trademark Office's (USPTO's) computer records so that the earliest possible projected publication date can be assigned.

The projected publication date is 02/26/2015.

If applicant rescinded the nonpublication request before or on the date of "foreign filing,"[1] then no notice of foreign filing is required.

If applicant foreign filed the application after filing the above application and before filing the rescission, and the rescission did not also include a notice of foreign filing, then a notice of foreign filing (not merely a rescission) is required to be filed within 45 days of the date of foreign filing. See 35 U.S.C. § 122(b)(2)(B)(iii), and Clarification of the United States Patent and Trademark Office's Interpretation of the Provisions of 35 U.S.C. § 122(b)(2)(B)(ii)-(iv), 1272 Off. Gaz. Pat. Office 22 (July 1, 2003).

If a notice of foreign filing is required and is not filed within 45 days of the date of foreign filing, then the application becomes abandoned pursuant to 35 U.S.C. § 122(b)(2)(B)(iii). In this situation, applicant should either file a petition to revive or notify the Office that the application is abandoned. See 37 CFR 1.137(f). Any such petition to revive will be forwarded to the Office of Petitions for a decision. Note that the filing of the petition will not operate to stay any period of reply that may be running against the application.

Questions regarding petitions to revive should be directed to the Office of Petitions at (571) 272-3282.

[1] Note, for purpose of this notice, that "foreign filing" means "filing an application directed to the same invention in another country, or under a multilateral international agreement, that requires publication of applications 18 months after filing".

/gasgedom/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/36 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U. S. DEPARTMENT OF COMMERCE

RESCISSION OF PREVIOUS NONPUBLICATION REQUEST
(35 U.S.C. 122(b)(2)(B)(ii))
AND, IF APPLICABLE,
NOTICE OF FOREIGN FILING
(35 U.S.C. 122(b)(2)(B)(iii))

Send completed form to:
Mail Stop PG Pub
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
FAX: (571) 273-8300

Application Number	13/971,606
Filing Date	August 20, 2013
First Named Inventor	Gaetan Pennecot
Title	Devices and Methods for a Rotating LIDAR Pla
Atty Docket Number	13-873
Art Unit	3645
Examiner	Samantha K. Abraham

A request that the above-identified application not be published under 35 U.S.C. 122(b) (nonpublication request) was included with the above-identified application on filing pursuant to 35 U.S.C. 122(b)(2)(B)(i).
I hereby **rescind** the previous nonpublication request.

If a notice of foreign or international filing is or will be required by 35 U.S.C. 122(b)(2)(B)(iii) and 37 CFR 1.213(c), I hereby provide such notice. This notice is being provided no later than forty-five (**45**) days after the date of such foreign or international filing.

*If a notice of subsequent foreign or international filing required by 35 U.S.C. 122(b)(2)(B)(iii) and 37 CFR 1.213(c) was not filed within forty-five (**45**) days after the date of filing of the foreign or international application, the application is ABANDONED, and a petition to revive under 37 CFR 1.137(b) is required. See 37 CFR 1.137(f).*

/Richard A. Machonkin/	July 23, 2014
Signature	Date
Richard A. Machonkin	41,962
Typed or printed name	Registration Number, if applicable
312-913-0001	
Telephone Number	

This request must be signed in compliance with 37 CFR 1.33(b).

If information or assistance is needed in completing this form, please contact the Pre-Grant Publication Division at (703)605-4283 or by e-mail at PGPub@USPTO.gov.

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop PG Pub, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature		
Name (Print/Type)	Date	

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	19664412
Application Number:	13971606
International Application Number:	
Confirmation Number:	4985
Title of Invention:	DEVICES AND METHODS FOR A ROTATING LIDAR PLATFORM WITH A SHARED TRANSMIT/RECEIVE PATH
First Named Inventor/Applicant Name:	Gaetan Pennecot
Customer Number:	98929
Filer:	Richard A Machonkin
Filer Authorized By:	
Attorney Docket Number:	13-873
Receipt Date:	23-JUL-2014
Filing Date:	20-AUG-2013
Time Stamp:	17:34:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Rescind Nonpublication Request for Pre Grant Pub	13_873_Rescission.pdf	259673 6f2a60de540e34ce81ea444ee0aa3ddfeecc d756	no	2

Warnings:	
Information:	

Total Files Size (in bytes):	259673

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

98929 7590 06/16/2014

McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

EXAMINER
ABRAHAM, SAMANTHA K

ART UNIT	PAPER NUMBER
3645	

DATE MAILED: 06/16/2014

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/971,606	08/20/2013	Gaetan Pennecot	13-873	4985

TITLE OF INVENTION: DEVICES AND METHODS FOR A ROTATING LIDAR PLATFORM WITH A SHARED TRANSMIT/RECEIVE PATH

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	09/16/2014

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

98929 7590 06/16/2014
McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/971,606	08/20/2013	Gaetan Pennecot	13-873	4985

TITLE OF INVENTION: DEVICES AND METHODS FOR A ROTATING LIDAR PLATFORM WITH A SHARED TRANSMIT/RECEIVE PATH

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	09/16/2014

EXAMINER	ART UNIT	CLASS-SUBCLASS
ABRAHAM, SAMANTHA K	3645	356-004010

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29
  NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27
  NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status.
  NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/971,606	08/20/2013	Gaetan Pennecot	13-873	4985

98929 7590 06/16/2014

McDonnell Boehnen Hulbert & Berghoff
LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

EXAMINER	
ABRAHAM, SAMANTHA K	
ART UNIT	PAPER NUMBER
3645	

DATE MAILED: 06/16/2014

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/971,606	Applicant(s) PENNECOT ET AL.	
	Examiner SAMANTHA K. ABRAHAM	Art Unit 3645	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *05/09/2014*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1,2,5-18,20 and 21*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Claims 1, 2, 5-18, 20, 21 pending.

Claims 3, 4, 19 cancelled.

Claims 1, 5, 6, 10, 17 amended.

Claim 21 added.

Response to Arguments

Applicant's arguments, filed 05/09/2014, have been fully considered and are persuasive. The 35 U.S.C. §112(b) indefiniteness rejection of claims 1 and 17 has been withdrawn. The 35 U.S.C. § 103 rejection of claims 1, 2, 6-18 and 20 has been withdrawn.

Allowable Subject Matter

Claims 1, 2, 5-18, 20 and 21 allowed.

The following is an examiner's statement of reasons for allowance:

The closest prior art (Ohtomo) teaches a mirror that reflects range measuring light from a light emitter. The closest prior art (Carlhoff) teaches a single optical beam with a single transmission direction. Carlhoff teaches a particular angle between the normal of the reflecting surface and the direction of the optical beam, teaching away from the instant claims. No combination of the closest prior art teaches or suggests the limitations of claims 1 and 17, as best explained by Fig. 2 of the instant specification, wherein a plurality of emitters transmit light though an aperture of a reflective surface in multiple different directions, though a single lens

toward an object. The reflected light transmitted through the same lens and further reflected off the reflective aperture surface toward a plurality of detectors.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Telephone Inquiry

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMANTHA K. ABRAHAM whose telephone number is (571)270-1037. The examiner can normally be reached on M-F 8:30AM-5:00PM ET.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Isam Alsomiri can be reached on (571) 272-6970. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would

like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAMANTHA K. ABRAHAM/
Examiner, Art Unit 3645

/ISAM ALSOMIRI/
Supervisory Patent Examiner, Art Unit 3645

Notice of References Cited	Application/Control No. 13/971,606	Applicant(s)/Patent Under Reexamination PENNECOT ET AL.	
	Examiner SAMANTHA K. ABRAHAM	Art Unit 3645	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-7,259,838	08-2007	Carlhoff et al.	356/5.04
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L4	43	(g01n15/0205.cpc. or g01n15/1459.cpc. or g01n21/29.cpc. or g01n2015/1486.cpc. or g01n21/53.cpc. or g01n21/538.cpc. or g01n2021/4709.cpc. or g01n21/21.cpc. or g01p3/36.cpc. or g01p5/26.cpc. or g01p3/366.cpc. or g01s17/50.cpc. or g01s17/58.cpc.) and ((aperture with reflect$4) and ((multiple or plurality or three or several) with detect$4 with transmit$7))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:39
L6	36	(g01n15/0205.cpc. or g01n15/1459.cpc. or g01n21/29.cpc. or g01n2015/1486.cpc. or g01n21/53.cpc. or g01n21/538.cpc. or g01n2021/4709.cpc. or g01n21/21.cpc. or g01p3/36.cpc. or g01p5/26.cpc. or g01p3/366.cpc. or g01s17/50.cpc. or g01s17/58.cpc.) and ((aperture with wall) and ((multiple or plurality or three or several) with ((detect$4 or sens$4 or receiv$4) with (transmit$7 or emit$4 or source$4))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:41
L7	26	(356/337-342.ccls. or 356/28.0-28.5.clas.) and ((aperture with wall) and ((multiple or plurality or three or several) with ((detect$4 or sens$4 or receiv$4) with (transmit$7 or emit$4 or source$4))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:41
L8	36	(g01n15/0205.cpc. or g01n15/1459.cpc. or g01n21/29.cpc. or g01n2015/1486.cpc. or g01n21/53.cpc. or g01n21/538.cpc. or g01n2021/4709.cpc. or g01n21/21.cpc. or g01p3/36.cpc. or g01p5/26.cpc. or g01p3/366.cpc. or g01s17/50.cpc. or g01s17/58.cpc.) and ((aperture with wall) and ((multiple or plurality or three or several) with ((detect$4 or sens$4 or receiv$4) with (transmit$7 or emit$4 or source$4))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:42
L9	9	(356/337-342.ccls. or 356/28.0-28.5.clas.) and ((aperture with reflect$4) and ((multiple or plurality or three or several) with detect$4 with transmit$7))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:42
L10	26	(356/337-342.ccls. or 356/28.0-28.5.clas.) and ((aperture with wall) and ((multiple or plurality or three or several) with ((detect$4 or sens$4 or receiv$4) with (transmit$7 or emit$4 or source$4))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2014/05/16 19:43

			DERWENT; IBM_TDB			
L11	0	(356/337-342.ccls. or 356/28.0-28.5.clas.) and ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4 with beams with reflect$4 with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:52
L12	0	(g01n15/0205.cpc. or g01n15/1459.cpc. or g01n21/29.cpc. or g01n2015/1486.cpc. or g01n21/53.cpc. or g01n21/538.cpc. or g01n2021/4709.cpc. or g01n21/21.cpc. or g01p3/36.cpc. or g01p5/26.cpc. or g01p3/366.cpc. or g01s17/50.cpc. or g01s17/58.cpc.) and ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:53

		with beams with reflect$4 with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.				
L13	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4 with beams with reflect$4 with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:54
L16	23	(356/337-342.ccls. or 356/28.0.ccls. or 356/28.5.ccls.) and ((aperture with reflect$4) and ((multiple or plurality or three or several) with detect$4 with transmit$7))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/16 19:55
S1	12	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN.	US-PGPUB; USPAT	OR	ON	2014/02/05 14:24
S2	7	"2005050558".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 09:58
S3	6	"2004070438".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:05

S4	2	"7587109".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:05
S5	2	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:25
S6	0	356/4.01,3.01,4.07,5.01,5.09,9,625.ccls. AND (vehicle and (rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:28
S7	2	(vehicle and (rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:29
S8	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and (vehicle and (rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:31
S9	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:31
S10	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with	US-PGPUB; USPAT	OR	ON	2014/02/07 10:31

		wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same collect$4 same focus$4))				
S11	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:32
S12	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:32
S13	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and ((beams or lasers or light or sources) with wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:32
S14	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:33
S15	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:33
S16	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and (((laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:34
S17	8	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN.	US-PGPUB; USPAT	OR	ON	2014/02/07 10:48

		and (rotat$4 and detect$ and transmi$7 and lens)				
S18	10	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$5 or emit$7 or emis$7) and (detect$4 or sens$4 or receiv$4) and (aperture with transmi$4) and (aperture with receiv$4) and (lens with (collimat$4 and focus$4 and collect$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 11:07
S19	1678	((detect$4 and transmit$4) same (aperture$4)) and (lens with (collimat$4 and focus$4 and collect$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:15
S20	23	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((detect$4 and transmit$4) same (aperture$4)) and (lens with (collimat$4 and focus$4 and collect$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:15
S21	0	(08/948228).APP.	US-PGPUB; USOCR	OR	ON	2014/02/07 12:32
S22	44	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 and focus$4 and collect$4 and transmi$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:33
S23	446	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 and focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:34
S24	220	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:34
S25	79	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens near3 (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:34
S26	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.)	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2014/02/07 12:35

		AND ((lens near3 (transmitter and detector) with (collimat$4 with focus$4)))	EPO; JPO; DERWENT; IBM_TDB			
S27	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (transmitter and detector) with (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:35
S28	2	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (transmit$4 and detect$4) with (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:35
S29	51	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 with focus$4)) with (reflect$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:36
S30	266	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((mirror or reflect$4) near3 aperture)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:08
S31	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND (((mirror or reflect$4) near3 aperture) with (transparent near3 material near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:09
S32	4	(((mirror or reflect$4) near3 aperture) with (transparent near3 material near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:10
S33	0	(((mirror) near3 aperture) with (transparent near3 material near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:18
S34	0	(((mirror) with (transmitter and housing)) with (transparent near3 material near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:18
S35	0	(((mirror) with (transmitter and housing)) with (transparent near3 material))	US-PGPUB; USPAT;	OR	ON	2014/02/07 18:19

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S36	2	(((mirror) with (transmitter and housing)) same (transparent near3 material))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:19
S37	6	(housing with aperture with (laser or diode or transmitter) with mirror with transparent)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:20
S38	177	(housing with (laser or diode or transmitter) with mirror with transparent)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:21
S39	4	((housing near3 transparent near3 wall) same (laser or diode or transmitter) with mirror)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:21
S40	1154	(laser or transmitter) near3 mirror near3 (transparent (window or wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:25
S41	27	((laser or transmitter) near3 mirror near3 (transparent (window or wall)) near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:25
S42	5	(mirror near3 between near3 (laser or diode or light) near3 (transparent or window) near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:32
S43	249	(mirror near3 between near3 (laser or diode or light) near3 (transparent or window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:33

S44	62	(mirror near3 between near3 (laser) near3 (transparent or window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:33
S45	623	(mirror with laser with housing) with (window)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
S46	83	(LIDAR) and ((mirror with laser with housing) with (window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
S47	0	(LIDAR) and ((mirror near3 laser near3 housing) with (window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
S48	20	((mirror near3 laser near3 housing) with (window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
S49	3	((mirror near3 laser near3 housing) with (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:57
S50	3	((mirror near3 laser) with (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:57
S51	3	((mirror near3 laser) same (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:58
S52	3	((mirror with housing with laser) same (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2014/02/07 18:58

			DERWENT; IBM_TDB			
S53	12	((mirror with housing with laser) and (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:58
S54	14	(mirror near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:02
S55	0	(rangefinder) and (mirror near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:05
S56	14	(mirror near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:05
S57	1	(mirror near3 (positioned or disposed) near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:05
S58	14	(mirror near3 between near3 laser near3 housing) and (mirror near3 between detector near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:10
S59	2	(mirror near3 laser near3 housing) and (mirror near3 detector near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:15
S60	2	(mirror near3 laser near3 housing) and (mirror near3 detector near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:19
S61	0	(mirror near3 laser near3 housing) and (mirror near3 photodiode near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:19
S62	13	(mirror near3 (laser or transmitter or diode) near3 housing) and (mirror near3 (detector or sensor or photodiode or receiver) near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:20
S63	43	(mirror near3 aperture near3 transmi$5) and (mirror near3 aperture near3 receiv$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:22
S64	20	(mirror near3 aperture near3 transmi$5) and (mirror near3 aperture near3 detect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:31
S65	25	(mirror near3 aperture near3 laser) and	US-PGPUB;	OR	ON	2014/02/07

		(mirror near3 aperture near3 detect$4)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			19:32
S66	114	(aperture with transparent with mirror with cover$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:39
S67	0	(aperture with (transparent near3 wall near3 housing) with mirror with cover$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:41
S68	134	(aperture with (window) with mirror with cover$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:41
S69	229	(aperture with (window) with mirror with (block$4 or cover$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:41
S70	178	(rang$4) and (aperture with (window) with mirror with (block$4 or cover$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:42
S71	1	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND (rang$4) and (aperture with (window) with mirror with (block$4 or cover$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:42
S72	18	(transmi$5 with receiv$4 with overlap) with (LIDAR)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:19
S73	4	((transmi$5 near3 beam) with (receiv$4 near3 beam) with overlap) with (LIDAR)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2014/02/07 20:20

			IBM_TDB			
S74	253	((transmi$5 near3 beam) with (receiv$4 near3 beam) with overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:21
S75	191	((transmi$5 near3 beam) near3 (receiv$4 near3 beam) with overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:21
S76	191	(((transmi$5 near3 beam) near3 (receiv$4 near3 beam)) with overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:22
S77	112	(((transmi$5 near3 beam) near3 (receiv$4 near3 beam)) near3 overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:22
S78	24	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:22
S79	4	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap) and (lidar or ladar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:24
S80	9	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap) and (radar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:25
S81	7	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap) and (compact)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:27
S82	24	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap)	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2014/02/07 20:29

			EPO; JPO; DERWENT; IBM_TDB			
S83	133	(aspheric with toroidal with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
S84	0	(aspheric with toroidal with lens) with (curved near3 focal near3 surface)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
S85	0	(aspheric with toroidal with lens) with (curv$4 near3 focal near3 surface)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
S86	0	(aspher$4 with toroid$4 with lens) with (curv$4 near3 focal near3 surface)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
S87	366	(aspher$4 with toroid$4 with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
S88	53	(aspheric near3 toroidal near3' lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
S89	53	(aspheric near3 toroidal near3 lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
S90	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND (aspheric near3 toroidal near3 lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:39
S91	0	(aspheric near3 outside near3 housing) with (toroidal near3 inside near3	US-PGPUB; USPAT;	OR	ON	2014/02/07 20:56

		housing)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S92	0	(aspheric near3 outside) with (toroidal near3 inside)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:56
S93	0	(aspher$4 near3 outside) with (toroid$4 near3 inside)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:57
S94	1	(aspher$4 near3 outside) same (toroid$4 near3 inside)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:57
S95	1	(aspher$4 near3 (out or outside)) same (toroid$4 near3 (inside or in))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:00
S96	1	"6778732".pn. and (aspheric with toroidal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:00
S97	0	(mirror near3 aperature near3 laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:19
S98	441	(mirror near3 aperture near3 laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:20
S99	30	(mirror near3 between near3 aperture near3 laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:20

S100	6	(mirror near3 aperture near3 laser) and (lidar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:22
S101	9	emit$4 near3 toward near3 mirror near3 aperture	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:23
S102	516	(receiv$4 with (inert near3 gas) with seal$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:29
S103	0	(receiv$4 with (inert near3 gas) with seal$4) and (lidar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:29
S104	39	(receiv$4 with (light or beam) with (inert near3 gas) with seal$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:30
S105	1	"7969558".pn. and (laser near3 diode)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:41
S106	5	pennecot-gaetan.inv. or droz-pierre-yves.inv. or ulrich-drew.inv. or gruver-daniel.inv. or morriss-zachary.inv. or levandowski-anthony.inv.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 22:11
S107	1780	((reflect$4 near3 wall) with aperture)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/29 10:28
S108	7	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((reflect$4 near3 wall) with	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2014/04/29 10:28

		aperture)	DERWENT; IBM_TDB			
S109	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((reflect$4 near3 surface near3 wall) with aperture)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/29 10:35
S110	100	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((reflect$4 near3 surface) with aperture)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/29 10:35
S111	29	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((reflect$4 near3 surface near3 aperture))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/29 10:36
S112	1	"7969558".pn. and (lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/14 14:54

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L14	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4 with beams with reflect$4	US-PGPUB; USPAT; UPAD	OR	ON	2014/05/16 19:54

		with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.				
L15	0	(g01n15/0205.cpc. or g01n15/1459.cpc. or g01n21/29.cpc. or g01n2015/1486.cpc. or g01n21/53.cpc. or g01n21/538.cpc. or g01n2021/4709.cpc. or g01n21/21.cpc. or g01p3/36.cpc. or g01p5/26.cpc. or g01p3/366.cpc. or g01s17/50.cpc. or g01s17/58.cpc.) and ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4 with beams with reflect$4 with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/05/16 19:54
L17	0	(356/337-342.ccls. or 356/28.0.ccls. or 356/28.5.ccls.) and ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4 with beams with reflect$4 with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/05/16 19:55

L18	0	356/4.01,3.01,4.07,5.01,5.09,9,625.ccls. AND ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4 with beams with reflect$4 with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/05/16 19:56
L19	0	(356/337-342.ccls. or 356/28.0.ccls. or 356/28.5.ccls.) and ((lidar) and (lens with mount$4 with housing with rotat$4 with axis with interior with space with (transmi$5 near3 block) with (receiv$4 near3 block) with (transmi$5 near3 path) with (receiv$4 near3 path)) and (exit with aperture with wall with reflect$4) and ((receiv$4 near3 block) with entrance with aperture) and (transmi$5 with path with extend$4 with exit with aperture with lens) and ((receiv$4 with path with extend$4 with lens with entrance with aperture with reflect$4) and (plurality with light with sources with (tranmi$5 near3 block) with emit$5 with plurality with light with beams with exit with aperture with plurality with different with directions)) and (light with beams with wavelength with range) and (plurality with detectors with (receiv$4 near3 block) with detect$4 with light with wavelength$4 with range) and (lens with receiv$4 with light with beams with (tranmi$5 near3 path) with collimat$4 with light with beams with environment) and (collect$4 with light with collimat$4 with beams with reflect$4 with object$4 with environment) and (focus$4 with collect$4 with light with detector$4 with receiv$4 with path)).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/05/16 19:56

5/16/2014 8:41:09 PM
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13971606	PENNECOT ET AL.
	Examiner	**Art Unit**
	SAMANTHA K ABRAHAM	3645

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/07/2014	05/16/2014							
	1	✓	=							
	2	✓	=							
	3	✓	-							
	4	✓	-							
	5	O	=							
	6	✓	=							
	7	✓	=							
	8	✓	=							
	9	✓	=							
	10	✓	=							
	11	✓	=							
	12	✓	=							
	13	✓	=							
	14	✓	=							
	15	✓	=							
	16	✓	=							
	17	✓	=							
	18	✓	=							
	19	✓	-							
	20	✓	=							
	21		=							

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13971606	PENNECOT ET AL.
	Examiner	**Art Unit**
	SAMANTHA K ABRAHAM	3645

CPC						
Symbol					**Type**	**Version**
G01S		17	/	02	F	2013-01-01
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

/SAMANTHA K ABRAHAM/ Examiner.Art Unit 3645	05/16/2014	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	18	
/ISAM ALSOMIRI/ Supervisory Patent Examiner.Art Unit 3645	05/19/2014	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Issue Classification	**Application/Control No.**	**Applicant(s)/Patent Under Reexamination**
	13971606	PENNECOT ET AL.
	Examiner	**Art Unit**
	SAMANTHA K ABRAHAM	3645

US ORIGINAL CLASSIFICATION						**INTERNATIONAL CLASSIFICATION**										
CLASS	**SUBCLASS**					**CLAIMED**						**NON-CLAIMED**				
356	4.01					G	0	1	C	3 / 08 (2006.0)						
CROSS REFERENCE(S)																
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**															
356	3.01	5.01	5.09	4.07	9											
356	625	337	342	28	28.5											

/SAMANTHA K ABRAHAM/ Examiner.Art Unit 3645 (Assistant Examiner)	05/16/2014 (Date)	**Total Claims Allowed:** 18	
/ISAM ALSOMIRI/ Supervisory Patent Examiner.Art Unit 3645 (Primary Examiner)	05/19/2014 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

Issue Classification	**Application/Control No.**	**Applicant(s)/Patent Under Reexamination**
	13971606	PENNECOT ET AL.
	Examiner	**Art Unit**
	SAMANTHA K ABRAHAM	3645

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	15	17												
2	2	16	18												
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	4	17	20												
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12	14														
13	15														
14	16														

/SAMANTHA K ABRAHAM/ Examiner.Art Unit 3645 (Assistant Examiner)	05/16/2014 (Date)	**Total Claims Allowed:** 18	
/ISAM ALSOMIRI/ Supervisory Patent Examiner.Art Unit 3645 (Primary Examiner)	05/19/2014 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13971606	PENNECOT ET AL.
	Examiner	Art Unit
	SAMANTHA K ABRAHAM	3645

CPC- SEARCHED		
Symbol	Date	Examiner
G01C 3/08, 15/002, 11/025, 11/025, 21/30; G01S 17/89, 7/4817, 17/42	02/07/2014	SKA
G01N 15/0205, 15/1459, 21/29, 2015/1486, 21/53, 21/538, 2021/4709, 21/21; G01P 3/36, 5/26, 3/366; G01S 17/50, 17/158	05/16/2014	SKA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
356	4.01, 3.01, 4.07, 5.01, 5.09, 9, 625	02/07/2014	SKA
356	337-342, 28.0, 28.5	05/16/2014	SKA

SEARCH NOTES		
Search Notes	Date	Examiner
East search	02/07/2014	SKA
NPL search	02/07/2014	SKA
East inventor search	02/07/2014	SKA
CPC search	02/07/2014	SKA
CPC search	05/16/2014	SKA
Consulted with SPE Isam Alsomiri on search strategy and allowability	05/16/2014	SKA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
G01N	15/0205, 15/1459, 21/29, 2015/1486, 21/53, 21/538, 2021/4709, 21/21	05/16/2014	SKA
G01P	3/36, 5/26, 3/366	05/16/2014	SKA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
G01S	17/50, 17/1158	05/16/2014	SKA
356	337-342, 28.0, 28.5, 3.01, 4.01, 4.07, 5.01, 5.09, 9, 625	05/16/2014	SKA

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket No. 13-873)

In re the Application of:	)	
	)	
Gaetan Pennecot et al.	)	
	)	**Group Art Unit: 3645**
Serial No.: 13/971,606	)	
	)	**Examiner: Samantha K. Abraham**
Filed: August 20, 2013	)	
	)	**Confirmation No. 4985**
For: Devices And Methods For A Rotating LIDAR Platform With A Shared Transmit/Receive Path	)	

RESPONSE TO OFFICE ACTION MAILED FEBRUARY 13, 2014

In response to the non-final Office Action mailed February 13, 2014, please enter the following amendments and consider the following remarks.

Amendments to the Claims begin on page 2 of this paper.

Remarks begin on page 7 of this paper.

Payment of Fees: Applicant submits that no fees are required for this Response. However, should any fee(s) be required under 37 C.F.R. §§ 1.16-1.21, please charge such fee(s) or credit any overpayment of such fee(s) to Deposit Account No. 13-2490.

Amendments to the Claims

1. (Currently Amended) A light detection and ranging (LIDAR) device, comprising:

a lens mounted to a housing, wherein the housing is configured to rotate about an axis~~,~~ ~~wherein the housing~~ and has an interior space that includes a transmit block, a receive block, a transmit path, and a receive path, ~~and a shared space,~~ wherein the transmit block has an exit aperture in a wall that comprises a reflective surface, [[and]] wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein the receive path extends from the lens to the entrance aperture via the reflective surface;

a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams ~~that enter the shared space~~ through the exit aperture in a plurality of different directions ~~and traverse the shared space via a transmit path~~, the light beams comprising light having wavelengths in a wavelength range;

a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and

~~a lens mounted to the housing,~~ wherein the lens is configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LIDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device, and focus the collected light onto the detectors via [[a]] the receive path ~~that extends through the shared space and the entrance aperture of the receive block~~.

2. (Original) The LIDAR device of claim 1, wherein each detector in the plurality of detectors is associated with a corresponding light source in the plurality of light sources, and

wherein the lens is configured to focus onto each detector a respective portion of the collected light that comprises light from the detector's corresponding light source.

3. (Cancelled)

4. (Cancelled)

5. (Currently Amended) The LIDAR device of claim [[4]] 1, wherein the wall comprises a transparent material, the reflective surface covers a portion of the transparent material, and the exit aperture corresponds to a portion of the transparent material that is not covered by the reflective surface.

6. (Currently Amended) The LIDAR device of claim 1, wherein the transmit path at least partially overlaps the receive path ~~in the shared space~~.

7. (Original) The LIDAR device of claim 1, wherein the lens defines a curved focal surface in the transmit block and a curved focal surface in the receive block.

8. (Original) The LIDAR device of claim 7, wherein the light sources in the plurality of light sources are arranged in a pattern substantially corresponding to the curved focal surface in the transmit block, and wherein the detectors in the plurality of detectors are arranged in a pattern substantially corresponding to the curved focal surface in the receive block.

9. (Original) The LIDAR device of claim 1, wherein the lens has an aspheric surface and a toroidal surface.

10. (Currently Amended) The LIDAR device of claim 9, wherein the toroidal surface is in the ~~shared~~ interior space within the housing and the aspheric surface is outside of the housing.

11. (Original) The LIDAR device of claim 1, wherein the axis is substantially vertical.

12. (Original) The LIDAR device of claim 1, further comprising a mirror in the transmit block, wherein the mirror is configured to reflect the light beams toward the exit aperture.

13. (Original) The LIDAR device of claim 1, wherein the receive block comprises a sealed environment containing an inert gas.

14. (Original) The LIDAR device of claim 1, wherein the entrance aperture comprises a material that passes light having wavelengths in the wavelength range and attenuates light having other wavelengths.

15. (Original) The LIDAR device of claim 1, wherein each light source in the plurality of light sources comprises a respective laser diode.

16. (Original) The LIDAR device of claim 1, wherein each detector in the plurality of detectors comprises a respective avalanche photodiode.

17. (Currently Amended) A method comprising:

rotating a housing of a light detection and ranging (LIDAR) device about an axis, wherein the housing mounts a lens and has an interior space that includes a transmit block, a receive block, a transmit path, and a receive path, ~~and a shared space,~~ wherein the transmit block has an exit aperture in a wall that comprises a reflective surface, [[and]] wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein the receive path extends from the lens to the entrance aperture via the reflective surface;

emitting, by a plurality of light sources in the transmit block, a plurality of light beams through the exit aperture in a plurality of different directions ~~that enter the shared space via a transmit path~~, the light beams comprising light having wavelengths in a wavelength range;

receiving, by the lens, the light beams ~~at a lens mounted to the housing along~~ via the transmit path;

collimating, by the lens, the light beams for transmission into an environment of the LIDAR device;

collecting, by the lens, light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device;

focusing, by the lens, the collected light onto a plurality of detectors in the receive block via [[a]] the receive path ~~that extends through the shared space and the entrance aperture of the receive block~~; and

detecting, by the plurality of detectors in the receive block, light from the focused light having wavelengths in the wavelength range.

18. (Original) The method of claim 17, wherein each detector in the plurality of detectors is associated with a corresponding light source in the plurality of light sources, the method further comprising:

focusing onto each detector, by the lens, a respective portion of the collected light that comprises light from the detector's corresponding light source.

19. (Cancelled)

20. (Original) The method of claim 17, further comprising:

reflecting, by a mirror in the transmit block, the emitted light beams toward the exit aperture.

21. (New) The method of claim 17, wherein the wall comprises a transparent material, the reflective surface covers a portion of the transparent material, and the exit aperture corresponds to a portion of the transparent material that is not covered by the reflective surface.

REMARKS

1. Introduction

In the Office Action mailed February 13, 2014, the Examiner rejected claims 1-4, 11, and 14-19 under 35 U.S.C. § 103 as being allegedly unpatentable over Hall, U.S. Patent No. 7,969,558 ("Hall") in view of Ohtomo et al., U.S. Patent No. 6,046,800 ("Ohtomo") and Wangler et al., U.S. Pub. No. 2002/0140924 ("Wangler"), rejected claim 6 under 35 U.S.C. § 103 as being allegedly unpatentable over Hall in view of Ohtomo and Wangler and further in view of Smith et al., U.S. Patent No. 7,311,000 ("Smith"), rejected claims 7-10 under 35 U.S.C. § 103 as being allegedly unpatentable over Hall in view of Ohtomo and Wangler and further in view of Fermann, U.S. Patent No. 6,778,732 ("Fermann"), rejected claims 12 and 20 under 35 U.S.C. § 103 as being allegedly unpatentable over Hall in view of Ohtomo and Wangler and further in view of Ozawa, U.S. Pub. No. 2010/0220141 ("Ozawa"), and rejected claim 13 under 35 U.S.C. § 103 as being allegedly unpatentable over Hall in view of Ohtomo and Wangler and further in view of Hirano, U.S. Patent No. 7,361,948 ("Hirano").

In addition, the Examiner rejected claims 1 and 17 under 35 U.S.C. § 112(b) as being allegedly indefinite.

The Examiner indicated that claim 5 contains allowable subject matter, but the Examiner objected to this claim as being dependent upon a rejected base claim.

In this Response, Applicant (i) amends claims 1, 5, 6, 10, and 17, (ii) cancels claims 3, 4, and 19 without prejudice, and (iii) adds new claim 21.

For the reasons set forth below, Applicant requests reconsideration and allowance of the application, as amended herein.

2. Interview Summary

Applicant thanks the Examiner for conducting a telephone interview to discuss the Office Action on April 29, 2014. The participants in the interview were Examiner Samantha K. Abraham and Applicant's representative, Richard A. Machonkin. During the interview, Applicant's representative argued that amendments to claims 1 and 17 as set forth herein (but without reference to "a plurality of different directions") would overcome the current rejections under § 112 and the current rejections under § 103 (based on Hall, Ohtomo, and Wangler), for the reasons set forth herein. The Examiner agreed. However, the Examiner also cited an additional reference during the interview as being potentially relevant: Carlhoff et al., U.S. Patent No. 7,259,838 ("Carlhoff"). Thus, no agreement was reached on allowability of the application.

3. Response to the Claim Rejections Under § 112

The Examiner alleged that the term "shared space" in claims 1 and 17 render these claims indefinite under 35 U.S.C. § 112(b). Without conceding to this rejection, but in order to expedite prosecution, Applicant has amended claims 1 and 17 to remove the references to "shared space." Accordingly, Applicant submits that the Examiner's rejection of claims 1 and 17 under § 112(b) is now moot.

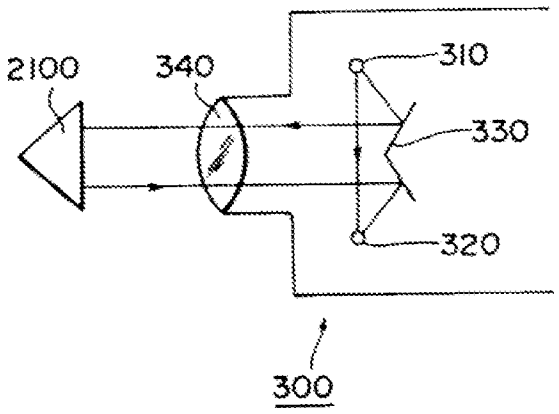
4. Response to the Claim Rejections under § 103 based on Hall, Ohtomo, and Wangler

Of the claims currently pending, claims 1 and 17 are independent. The Examiner rejected claims 1 and 17 under § 103 as being allegedly unpatentable over Hall in view of Ohtomo and Wangler. Without conceding to this rejection, but in order to expedite prosecution, Applicant

has amended claims 1 and 17 to recite "an interior space that includes a transmit block, a receive block, a transmit path, and a receive path, wherein the transmit block has an exit aperture in a wall that comprises a reflective surface, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein the receive path extends from the lens to the entrance aperture via the reflective surface." This amendment is supported by Applicant's specification at various places, for example, at paragraphs [0072] and [0073]. Applicant submits that amended claims 1 and 17 are clearly allowable over Hall in view of Ohtomo and Wangler, as set forth below.

In rejecting claim 4 (now cancelled), the Examiner asserted that "Hall lacks, but Ohtomo teaches a reflective surface proximate to the exit aperture [fig. 14, object 330], wherein the receive path includes reflection by the reflective surface [fig. 14, object 330]." *See* Office Action, p. 7. Figure 14 of Ohtomo is reproduced below:

FIG. 14



In Ohtomo's description of Fig. 14, Ohtomo describes object 330 (which corresponds to the claimed "reflective surface" in the Examiner's rationale) as mirror 330 and describes object 310 (which corresponds to the claimed "exit aperture" in the Examiner's rationale) as light emitting part 310. *See* col. 3, lines 44-57. More particularly, Ohtomo explains the physical arrangement

of mirror 330 and light emitting part 310 by referring to "a mirror 330 for reflecting the range measuring light from the light emitting part 310 toward the prism 2100." *See* col. 3, lines 51-53.

In contrast, amended claims 1 and 17 recite "an exit aperture in a wall that comprises a reflective surface." Applicant submits that Ohtomo's arrangement in which mirror 330 is arranged to reflect light from light emitting part 310 (the alleged "exit aperture") neither discloses nor suggests "an exit aperture in a wall that comprises a reflective surface," as recited in amended claim. Applicant further submits that Hall and Wangler do not make up for this deficiency in Ohtomo.

5. Response to the Examiner's citation of Carlhoff

As noted above, the Examiner cited Carlhoff during the interview as being potentially relevant. Even though the claims have not been rejected based on Carlhoff, Applicant has further amended claims 1 and 17 in order to expedite prosecution. In particular, Applicant has further amended claim 1 to recite "wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions" and has further amended claim 17 to recite "emitting, by a plurality of light sources in the transmit block, a plurality of light beams through the exit aperture in a plurality of different directions." These amendments are supported by at least paragraphs [0082] – [0084] of Applicant's specification and Figure 4 in the drawings.

Carlhoff neither discloses nor suggests emitting "a plurality of light beams through the exit aperture in a plurality of different directions," as recited in amended claims 1 and 17. Rather than a "plurality of light beams" with a "plurality of different directions," Carlhoff teaches a single optical beam 118 with a single transmission direction:

> The reflecting surface 104 of the reflecting component 102 is positioned at an angle with respect to the common optical channel 108 and to the optical beam both in the transmission and the reception directions. The normal of the reflecting surface 104 with respect to the direction of the optical beam 118 has an angle α, the value of which differs from zero. A possible value for the angle is, for example, around 45 degrees, but is not limited to this.
>
> The aperture 106 extends from the reflecting surface 104 through the optical beam separation element 100 for passing the optical beam 118 of the transmission direction through the optical beam separation element 100 to the common optical channel 108.

See col. 3, lines 38-30. Indeed, by referring to a particular angle, α, between the normal of the reflecting surface 104 and the direction of the optical beam 118, Carlhoff teaches away from a "plurality of light beams" with a "plurality of different directions."

Accordingly, Applicant submits that claims 1 and 17, as amended, are allowable over Hall, Ohtomo, Wangler, and Carlhoff for at least the foregoing reasons. Applicant further submits that claims 2, 5-16, 18, 20, and 21 are allowable for at least the reason that they depend from allowable independent claims.

6. Conclusion

Applicant submits that the present application is in condition for allowance, and notice to that effect is hereby requested. Should the Examiner feel that further dialog would advance the subject application to issuance, the Examiner is invited to telephone the undersigned at any time at (312) 913-0001.

Respectfully submitted,

Date: May 9, 2014

By: /Richard A. Machonkin/
Richard A. Machonkin
Reg. No. 41,962

Electronic Acknowledgement Receipt

EFS ID:	18992931
Application Number:	13971606
International Application Number:	
Confirmation Number:	4985
Title of Invention:	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/ Receive Path
First Named Inventor/Applicant Name:	Gaetan Pennecot
Customer Number:	98929
Filer:	Richard A Machonkin
Filer Authorized By:	
Attorney Docket Number:	13-873
Receipt Date:	09-MAY-2014
Filing Date:	20-AUG-2013
Time Stamp:	16:30:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		13-873_Response.pdf	132284 5f5fceadeed8b51ae76a05e8a0062ae7308b3baa	yes	11

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	6
Applicant Arguments/Remarks Made in an Amendment	7	11

Warnings:	
Information:	
Total Files Size (in bytes):	132284

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/971,606	Filing Date 08/20/2013	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **05/09/2014**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 18	Minus	** 20	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/DEBORAH POLLARD/

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/971,606	08/20/2013	Gaetan Pennecot	13-873	4985

98929 7590 05/06/2014

McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

EXAMINER	
ABRAHAM, SAMANTHA K	
ART UNIT	**PAPER NUMBER**
3645	

MAIL DATE	DELIVERY MODE
05/06/2014	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Applicant-Initiated Interview Summary	**Application No.** 13/971,606	**Applicant(s)** PENNECOT ET AL.	
	Examiner SAMANTHA K. ABRAHAM	**Art Unit** 3645	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAMANTHA K. ABRAHAM*. (3)_____.

(2) *Richard A. Machonkin (Applicants' Representative)*. (4)_____.

Date of Interview: *29 April 2014*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☒112 ☐102 ☒103 ☒Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1, 5 (and consequently 17 and 21)*.

Identification of prior art discussed: *Hall, Ohtomo, and Wangler*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Examiner and Mr. Machonkin discussed the § 112b (indefiniteness) rejection of claims 1 and 17 as well as proposed amendments and the application of previously applied prior art. .

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/SAMANTHA K. ABRAHAM/ Examiner, Art Unit 3645	/ISAM ALSOMIRI/ Supervisory Patent Examiner, Art Unit 3645

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

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Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/971,606	08/20/2013	Gaetan Pennecot	13-873	4985

98929 7590 02/13/2014

McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

EXAMINER	
ABRAHAM, SAMANTHA K	
ART UNIT	PAPER NUMBER
3645	
MAIL DATE	DELIVERY MODE
02/13/2014	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/971,606	Applicant(s) PENNECOT ET AL.	
	Examiner SAMANTHA K. ABRAHAM	Art Unit 3645	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08/20/2013*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-20* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-4 and 6-20* is/are rejected.

8)☒ Claim(s) *5* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *08/20/2013* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *08/21/2013*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1 and 17 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claims 1 and 17 recite the limitation *"shared space"*, which is rendered indefinite, as the Claims do not provide a clear understanding of what is meant by the limitation. Claim 6 offers that the transmit and receive paths at least partially overlap in the shared space. Looking to the Specification for clarity, ¶0059 indicates that, *"in some examples, the transmit path at least partially overlaps with the receive path in the shared space"*. Further, ¶0060 of the Specification provides that *"the shared space can include a reflective surface"* for the purpose of directing a light beam. However, while possible characteristics of the shared space are offered in both the Claims and the Specification, it remains unclear as to what the shared space actually is, in a physical capacity. Therefore, for the purposes of claim interpretation, the shared space will be interpreted to mean a region provided between the transmitter(s)/receiver(s) and the lens or the

edge of the housing in which these components are placed where the optical paths of both the transmitted and received light pass.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-4, 11, and 14-19 are rejected under 35 U.S.C. 103 as being unpatentable over Hall (US 7,969,558) in view of Ohtomo (US 6,046,800) and further in view of Wangler (US 2002/0140924).

Claims 1 and 17: Hall teaches a light detection and ranging (LIDAR) device [abstract; col 3, ln 65-67], comprising:

a housing [abstract; col 6, ln 56-63; fig. 13 and 14 (objects 152 and 158 collectively, or 158 specifically)] configured to rotate about an axis [abstract; col 6, ln 56-63], wherein the housing has an interior space [fig. 13 and 14 (objects 152, 150 (specifically 154 and 156)] that includes a transmit block [col 7, ln 10-12], a receive block [col 7, ln 3-5 (the detectors collectively forming a receive unit)]; a plurality of light sources in the transmit block [col 7, ln 10-12], wherein the plurality of light sources are configured to emit a plurality of light beams [col 7, ln 10-12], the light beams comprising light having wavelengths in a wavelength range [col 5, ln 5-6: Though, to one of ordinary skill in the art, it would be reasonable to consider that laser diodes of different (or slightly different) wavelengths could be employed implicitly in Hall, so as to vary the characteristics of the laser light beams. *In re Preda*, 401 F.2d 825, 826, 159 USPQ 342, 344 (CCPA 1968)];

a plurality of detectors in the receive block [col 7, ln 3-5], wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range [col 5, ln 5-6: The photo diodes would receive light of the same wavelength emitted from the laser diodes. Though, to one of ordinary skill in the art, it would be reasonable to consider that laser diodes of different (or slightly different) wavelengths could be employed implicitly in Hall, so as to vary the characteristics of the laser light beams. *In re Preda*, 401 F.2d 825, 826, 159 USPQ 342, 344 (CCPA 1968)]; and

Hall lacks, but Ohtomo teaches a shared space [fig. 14, the region between 310 and 320, which includes 330] and light that enters the shared space through the exit aperture and traverse the shared space via a transmit path [fig. 14, the region between 310 and 320, which includes 330], a lens mounted to the housing [fig. 14, object 340); col 3, ln 47-57], wherein the lens is

configured to receive the light beams via the transmit path [fig. 14, object 340, receiving light from 310); col 3, ln 47-57], collimate the light beams for transmission into an environment of the LIDAR device [fig. 14, object 340 toward object 2100); col 3, ln 47-57], collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device [fig. 14, object 340 from object 2100); col 3, ln 47-57], and focus the collected light onto the detectors via a receive path [fig. 14, object 340 toward object 320); col 3, ln 47-57] that extends through the shared space [fig. 14, the region between 310 and 320, which includes 330] and the entrance aperture of the receive block [as taught by Wangler].

Hall lacks, but Wangler teaches wherein the transmit block has an exit aperture [fig. 1, object 524; ¶ 0007, 0052], and wherein the receive block has an entrance aperture [fig. 1, object 526; ¶ 0007, 0052].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the shared space, and multi-functional lens of Ohtomo and to further include the transmit and receive apertures of Wangler because the shared space indicates a region in which an optical component directs both the transmitted light to a target from the transmitter and the received light from the target to the receiver [Ohtomo: col 3, ln 47-57; fig. 14]. The multi-functional lens allows for light emitted from the transmitter to be collimated in order to cause the reflected light from a target to be focused on the light receiving part [Ohtomo: col 3, ln 47-57; fig. 14]. Further, the [opening of] transmit and receive apertures control the collimation and focus of the optical system on the image plane.

Claims 2 and 18: Hall teaches each detector in the plurality of detectors is associated with a corresponding light source in the plurality of light sources [col 3, ln 15-17; col 4, ln 59-63], and wherein the lens is configured to focus onto each detector a respective portion of the collected light that comprises light from the detector's corresponding light source [col 1, ln 11-18].

Ohtomo further teaches lens is configured to focus onto each detector a respective portion of the collected light that comprises light from the detector's corresponding light source [fig. 14; col 3, ln 47-57].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the lens configured to focus light from a detector to a corresponding light source in order to reflect range measurement light transmitted from a laser source in order to cause the reflected light from a target to be focused on the corresponding receiving part to achieve a particular range measurement [Ohtomo: col 3, ln 47-57].

Claim 3: Hall lacks, but Wangler teaches the exit aperture is in a wall that separates the transmitter [transmit block] from a region beyond the transmitter [shared space as taught by Ohtomo] [fig. 2, object 524].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the exit aperture in a wall of a transmitter, the aperture separating the transmitter from a region beyond the transmitter because the opening of transmit aperture helps to control the collimation of the optical system on the image plane.

Claim 4: Hall lacks, but Ohtomo teaches a reflective surface proximate to the exit aperture [fig. 14, object 330], wherein the receive path includes reflection by the reflective surface [fig. 14, object 330].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the mirror (reflecting surface) of Ohtomo in order to reflect the range measuring light from the transmitter toward the target and causing the reflected light from the target to be face the receiver [Ohtomo: col 3, ln 47-57].

Claim 11: Hall teaches the axis is substantially vertical [fig. 9 and 13; col 6, ln 50-63].

Claim 14: Hall teaches a [lens surface treated with a] material that passes light having wavelengths in the wavelength range and attenuates light having other wavelengths [col 5, ln 5-8: To one of ordinary skill in the art, it would be reasonable to consider that a UV treated surface indicates a material coating. *In re Preda*, 401 F.2d 825, 826, 159 USPQ 342, 344 (CCPA 1968)].

Hall lacks, but Wangler teaches the entrance aperture [¶ 0007, 0052].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the entrance aperture of Wangler with a material to pass certain wavelengths and to attenuate others in order to ensure that the appropriate range measurement light is received at a detector [Hall: col 3, ln 15-17; col 4, ln 59-63].

Claim 15: Hall teaches each light source in the plurality of light sources comprises a respective laser diode [col 4, ln 59-63].

Claim 16: Hall teaches each detector in the plurality of detectors comprises a respective avalanche photodiode [col 5, ln 5-7].

Claim 19: Hall lacks, but Ohtomo teaches reflecting, by a reflective surface in the shared space, the focused light along the receive path toward the [entrance aperture (as taught by Wangler) of the receive block (as taught by Hall)] [fig. 14, object 330; col 3, ln 47-57], wherein the reflective surface is proximate to the transmitter [exit aperture (as taught by Wangler)] [fig. 14 (objects 310 and 330)], and wherein the receive path includes the reflecting by the reflective surface [fig. 14, object 330; col 3, ln 47-57].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the mirror (reflecting surface) of Ohtomo in order to reflect the range measuring light from the transmitter toward the target and causing the reflected light from the target to be face the receiver [Ohtomo: col 3, ln 47-57].

Claim 6 is rejected under 35 U.S.C. 103 as being unpatentable over Hall (US 7,969,558) in view of Ohtomo (US 6,046,800) and further in view of Wangler (US 2002/0140924) and further in view of Smith (US 7,311,000).

Claim 6, Hall lacks, but Smith teaches the transmit path at least partially overlaps the receive path in the [shared space (as taught by Ohtomo)] [col 5, ln 35-37].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the overlapping transmit and receive beams so as to define a certain probe volume in space [Smith: col 5, ln 35-37].

Claims 7-10 are rejected under 35 U.S.C. 103 as being unpatentable over Hall (US 7,969,558) in view of Ohtomo (US 6,046,800) and further in view of Wangler (US 2002/0140924) and further in view of Fermann (US 6,778,732).

Claim 7: Hall lacks, but Fermann teaches the lens defines a curved focal surface [in the transmit block as taught by Hall] and a curved focal surface [in the receive block as taught by Hall] [col 7, ln 28-34: It is known in the art that aspheric, toroidal lenses result in a curved focal surface].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the curved focal surface resulting from the aspheric, toroidal lens of Fermann to minimize spherical aberrations and astigmatism [Fermann: col 7, ln 28-34].

Claim 8: Hall teaches the light sources in the plurality of light sources are arranged in a pattern substantially corresponding to the curved focal surface in the transmit block [fig 19, (object 180)], and wherein the detectors in the plurality of detectors are arranged in a pattern substantially corresponding to the curved focal surface in the receive block [Hall does not explicitly teach that the plurality of detectors are arranged in the same way as are the plurality of emitters, however, it would be obvious to one of ordinary skill in the art to form the detectors in

such a way in order to achieve a symmetrical optical system. *In re Preda*, 401 F.2d 825, 826, 159 USPQ 342, 344 (CCPA 1968)].

Claim 9: Hall lacks, but Fermann teaches the lens has an aspheric surface and a toroidal surface [col 7, ln 28-34].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the curved focal surface resulting from the aspheric, toroidal lens of Fermann to minimize spherical aberrations and astigmatism [Fermann: col 7, ln 28-34].

Claim 10, Hall lacks, but Fermann teaches the toroidal surface [col 7, ln 28-34] [is in the shared space within the housing] and the aspheric surface [col 7, ln 28-34] [is outside of the housing].

It would be obvious to one of ordinary skill in the art to orient an aspheric, toroidal lens, such that light emitted toward the lens and entering through the toroidal side, results in more efficient refraction and directs light over a greater area. Further, light reflected from an object toward the lens and entering through the aspheric side, results in the elimination of aberrations of the light reflected from the object. Thus, while the orientation of the aspheric, toroidal lens is not explicitly taught by Hall or Fermann, but the incorporation and orientation of such a lens would be obvious given the nature of the art.

Thus, it would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the curved focal surface resulting from the aspheric, toroidal lens of Fermann to minimize spherical aberrations and astigmatism [Fermann: col 7, ln 28-34].

Claims 12 and 20 are rejected under 35 U.S.C. 103 as being unpatentable over Hall (US 7,969,558) in view of Ohtomo (US 6,046,800) and further in view of Wangler (US 2002/0140924) and further in view of Ozawa (US 2010/0220141).

Claims 12 and 20: Hall lacks, but Ozawa teaches a mirror [in the transmit block as taught by Hall] [¶0024], wherein the mirror is configured to reflect the light beams toward the exit aperture [¶0024].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the mirror of Ozawa in order to reflect light from the light source toward the aperture [Ozawa: ¶0024].

Claim 13 is rejected under 35 U.S.C. 103 as being unpatentable over Hall (US 7,969,558) in view of Ohtomo (US 6,046,800) and further in view of Wangler (US 2002/0140924) and further in view of Hirano (US 7,361,948).

Claim 13: Hall lacks, but Hirano teaches the receive block comprises a sealed environment containing an inert gas [col 5, ln 53-67; col 15, ln 37-48].

It would be obvious to one of ordinary skill in the art at the time of invention to modify the LIDAR system of Hall to include the inert gas within a sealed environment that also includes a light receiver, is such that the inert gas acts as a filter device [Hirano: col 5, ln 53-67; col 15, ln 37-48].

Allowable Subject Matter

Claim 5 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 5 teaches *"a wall teaches a transparent material, the reflective surface covers a portion of the transparent material, and the exit aperture corresponds to a portion of the transparent material that is not covered by the reflective surface"*. Reference Ohtomo teaches a mirror positioned near (and between) the transmitting and receiving units, at which the light transmitted from the transmitter is directed toward a target object, and at which the light reflected from the target object is directed toward the receiving unit. Reference Wangler teaches apertures corresponding to a light emitting unit and to a light receiving unit. Reference Grainge (US 4,516,158) teaches a housing with an aperture through which a mirror receives radiation; the aperture preferable covered by a transparent window. However, none of the previously cited references in the rejection of Claims 1, 3, or 4 (on all of which Claim 5 depends), nor Grainge teach or imply that the exit aperture corresponds to a portion of a window (transparent material) that is not covered by the mirror (reflective surface). Therefore, the no less than four references that teach the majority of the limitations of Claim 5 render the remaining limitation obvious. Further, as a result of an appropriate search, there is no prior art that sufficiently (either explicitly or implicitly) teaches a relationship between an aperture, a mirror and a window as indicated by the closest cited prior art.

Telephone Inquiry

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMANTHA K. ABRAHAM whose telephone number is (571)270-1037. The examiner can normally be reached on M-F 8:30AM-5:00PM ET.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Isam Alsomiri can be reached on (571) 272-6970. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAMANTHA K. ABRAHAM/
Examiner, Art Unit 3645

/ISAM ALSOMIRI/
Supervisory Patent Examiner, Art Unit 3645

Notice of References Cited	Application/Control No. 13/971,606	Applicant(s)/Patent Under Reexamination PENNECOT ET AL.	
	Examiner SAMANTHA K. ABRAHAM	Art Unit 3645	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,046,800	04-2000	Ohtomo et al.	356/141.1
*	B	US-2002/0140924	10-2002	Wangler et al.	356/28
*	C	US-7,311,000	12-2007	Smith et al.	73/170.11
*	D	US-6,778,732	08-2004	Fermann, Martin E.	385/31
*	E	US-2010/0220141	09-2010	Ozawa, Chizuo	347/18
*	F	US-7,361,948	04-2008	Hirano et al.	257/294
*	G	US-4,516,158	05-1985	Grainge et al.	348/145
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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	S					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Receipt date: 08/20/2013 13971606 - GAU: 3645
Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed
PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2013-08-20
First Named Inventor	Gaetan Pennecot
Art Unit	
Examiner Name	
Attorney Docket Number	13-873

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	3790277		1974-02-05	Hogan	
	2	4700301		1987-10-13	Dyke	
	3	4709195		1987-11-24	Hellekson et al.	
	4	5202742		1993-04-13	Frank et al.	
	5	7089114	B1	2006-08-08	Huang	
	6	7248342	B1	2007-07-24	Degnan	
	7	7255275	B2	2007-08-14	Gurevich et al.	
	8	7969558	B2	2011-06-28	Hall	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.K.A

Receipt date: 08/20/2013	Application Number	13971606 - GAU: 3645
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2013-08-20
	First Named Inventor	Gaetan Pennecot
	Art Unit	
	Examiner Name	
	Attorney Docket Number	13-873

	9	5703351		1997-12-30	Meyers	
	10	7417716	B2	2008-08-26	Nagasaka et al.	
	11	7544945	B2	2009-06-09	Tan et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110216304	A1	2011-09-08	Hall	

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	1	2410358	EP	A1	2012-01-25	European Space Agency		☐

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	1		☐

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Receipt date: 08/20/2013	Application Number	13971606 - GAU: 3645
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2013-08-20
	First Named Inventor	Gaetan Pennecot
	Art Unit	
	Examiner Name	
	Attorney Docket Number	13-873

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EXAMINER SIGNATURE

Examiner Signature	/Samantha Kaye Abraham/	Date Considered	02/07/2014

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.K.A

Receipt date: 08/20/2013

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13971606 - GAU: 3645
Filing Date	2013-08-20
First Named Inventor	Gaetan Pennecot
Art Unit	
Examiner Name	
Attorney Docket Number	13-873

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Richard A. Machonkin/	Date (YYYY-MM-DD)	2013-08-20
Name/Print	Richard A. Machonkin	Registration Number	41962

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.K.A

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	7	"2005050558".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 09:58
L2	6	"2004070438".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:05
L3	2	"7587109".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:05
L4	2	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:25
L5	0	356/4.01,3.01,4.07,5.01,5.09,9,625.ccls. AND (vehicle and (rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:28
L6	2	(vehicle and (rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 10:29
L7	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN.	US-PGPUB; USPAT	OR	ON	2014/02/07 10:31

		and (vehicle and (rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))				
L8	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same receiv$4 same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:31
L9	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same collect$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:31
L10	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 with receiv$4 with aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:32
L11	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (sources with wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:32
L12	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and ((beams or lasers or light or sources) with wavelength) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:32
L13	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN.	US-PGPUB; USPAT	OR	ON	2014/02/07 10:33

		and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (detectors or sensors or receivers) and (lens same collimat$4 same focus$4))				
L14	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:33
L15	0	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and (((laser or lidar or scan$4)) and (transmi$4 same receiv$4 same aperture$4) and (lens same collimat$4 same focus$4))	US-PGPUB; USPAT	OR	ON	2014/02/07 10:34
L16	8	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN. and (rotat$4 and detect$ and transmi$7 and lens)	US-PGPUB; USPAT	OR	ON	2014/02/07 10:48
L17	10	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((rotat$4 near3 (laser or lidar or scan$4)) and (transmi$5 or emit$7 or emis$7) and (detect$4 or sens$4 or receiv$4) and (aperture with transmi$4) and (aperture with receiv$4) and (lens with (collimat$4 and focus$4 and collect$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 11:07
L18	1678	((detect$4 and transmit$4) same (aperture$4)) and (lens with (collimat$4 and focus$4 and collect$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:15
L19	23	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((detect$4 and transmit$4) same (aperture$4)) and (lens with (collimat$4 and focus$4 and collect$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:15
L20	0	(08/948228).APP.	US-PGPUB; USOCR	OR	ON	2014/02/07 12:32
L21	44	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 and focus$4 and collect$4 and transmi$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:33

L22	446	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 and focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:34
L23	220	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:34
L24	79	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens near3 (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:34
L25	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens near3 (transmitter and detector) with (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:35
L26	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (transmitter and detector) with (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:35
L27	2	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (transmit$4 and detect$4) with (collimat$4 with focus$4)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:35
L28	51	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((lens with (collimat$4 with focus$4)) with (reflect$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 12:36
L29	266	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND ((mirror or reflect$4) near3 aperture)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:08
L30	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND (((mirror or reflect$4) near3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2014/02/07 18:09

		aperture) with (transparent near3 material near3 wall))	DERWENT; IBM_TDB			
L31	4	(((mirror or reflect$4) near3 aperture) with (transparent near3 material near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:10
L32	0	(((mirror) near3 aperture) with (transparent near3 material near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:18
L33	0	(((mirror) with (transmitter and housing)) with (transparent near3 material near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:18
L34	0	(((mirror) with (transmitter and housing)) with (transparent near3 material))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:19
L35	2	(((mirror) with (transmitter and housing)) same (transparent near3 material))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:19
L36	6	(housing with aperture with (laser or diode or transmitter) with mirror with transparent)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:20
L37	177	(housing with (laser or diode or transmitter) with mirror with transparent)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:21
L38	4	((housing near3 transparent near3 wall) same (laser or diode or transmitter) with mirror)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:21
L39	1154	(laser or transmitter) near3 mirror near3 (transparent (window or wall))	US-PGPUB; USPAT; USOCR;	OR	ON	2014/02/07 18:25

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
L40	27	((laser or transmitter) near3 mirror near3 (transparent (window or wall)) near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:25
L41	5	(mirror near3 between near3 (laser or diode or light) near3 (transparent or window) near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:32
L42	249	(mirror near3 between near3 (laser or diode or light) near3 (transparent or window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:33
L43	62	(mirror near3 between near3 (laser) near3 (transparent or window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:33
L44	623	(mirror with laser with housing) with (window)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
L45	83	(LIDAR) and ((mirror with laser with housing) with (window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
L46	0	(LIDAR) and ((mirror near3 laser near3 housing) with (window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
L47	20	((mirror near3 laser near3 housing) with (window))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:51
L48	3	((mirror near3 laser near3 housing) with	US-PGPUB;	OR	ON	2014/02/07

		(transparent near3 housing near3 wall))	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			18:57
L49	3	((mirror near3 laser) with (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:57
L50	3	((mirror near3 laser) same (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:58
L51	3	((mirror with housing with laser) same (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:58
L52	12	((mirror with housing with laser) and (transparent near3 housing near3 wall))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 18:58
L53	14	(mirror near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:02
L54	0	(rangefinder) and (mirror near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:05
L55	14	(mirror near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:05
L56	1	(mirror near3 (positioned or disposed) near3 between near3 laser near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:05
L57	14	(mirror near3 between near3 laser near3 housing) and (mirror near3 between detector near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:10
L58	2	(mirror near3 laser near3 housing) and (mirror near3 detector near3 housing)	US-PGPUB; USPAT	OR	ON	2014/02/07 19:15
L59	2	(mirror near3 laser near3 housing) and (mirror near3 detector near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:19
L60	0	(mirror near3 laser near3 housing) and (mirror near3 photodiode near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2014/02/07 19:19

			DERWENT; IBM_TDB			
L61	13	(mirror near3 (laser or transmitter or diode) near3 housing) and (mirror near3 (detector or sensor or photodiode or receiver) near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:20
L62	43	(mirror near3 aperture near3 transmi$5) and (mirror near3 aperture near3 receiv$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:22
L63	20	(mirror near3 aperture near3 transmi$5) and (mirror near3 aperture near3 detect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:31
L64	25	(mirror near3 aperture near3 laser) and (mirror near3 aperture near3 detect$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:32
L65	114	(aperture with transparent with mirror with cover$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:39
L66	0	(aperture with (transparent near3 wall near3 housing) with mirror with cover$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:41
L67	134	(aperture with (window) with mirror with cover$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:41
L68	229	(aperture with (window) with mirror with (block$4 or cover$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:41
L69	178	(rang$4) and (aperture with (window) with mirror with (block$4 or cover$4))	US-PGPUB; USPAT; USOCR;	OR	ON	2014/02/07 19:42

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
L70	1	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND (rang$4) and (aperture with (window) with mirror with (block$4 or cover$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 19:42
L71	18	(transmi$5 with receiv$4 with overlap) with (LIDAR)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:19
L72	4	((transmi$5 near3 beam) with (receiv$4 near3 beam) with overlap) with (LIDAR)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:20
L73	253	((transmi$5 near3 beam) with (receiv$4 near3 beam) with overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:21
L74	191	((transmi$5 near3 beam) near3 (receiv$4 near3 beam) with overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:21
L75	191	(((transmi$5 near3 beam) near3 (receiv$4 near3 beam)) with overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:22
L76	112	(((transmi$5 near3 beam) near3 (receiv$4 near3 beam)) near3 overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:22
L77	24	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:22
L78	4	(((transmi$5 adj beam) near3 (receiv$4	US-PGPUB;	OR	ON	2014/02/07

		adj beam)) near3 overlap) and (lidar or ladar)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			20:24
L79	9	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap) and (radar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:25
L80	7	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap) and (compact)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:27
L81	24	(((transmi$5 adj beam) near3 (receiv$4 adj beam)) near3 overlap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:29
L82	133	(aspheric with toroidal with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
L83	0	(aspheric with toroidal with lens) with (curved near3 focal near3 surface)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
L84	0	(aspheric with toroidal with lens) with (curv$4 near3 focal near3 surface)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
L85	0	(aspher$4 with toroid$4 with lens) with (curv$4 near3 focal near3 surface)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
L86	366	(aspher$4 with toroid$4 with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2014/02/07 20:38

			IBM_TDB			
L87	53	(aspheric near3 toroidal near3' lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
L88	53	(aspheric near3 toroidal near3 lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:38
L89	0	(G01C3/08.CPC. OR G01S17/89.CPC. OR G01S7/4817.CPC. OR G01S17/42.CPC. OR G01C15/002.CPC. OR G01C11/025.CPC. OR G01C15/02.CPC. OR G01C21/30.CPC.) AND (aspheric near3 toroidal near3 lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:39
L90	0	(aspheric near3 outside near3 housing) with (toroidal near3 inside near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:56
L91	0	(aspheric near3 outside) with (toroidal near3 inside)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:56
L92	0	(aspher$4 near3 outside) with (toroid$4 near3 inside)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:57
L93	1	(aspher$4 near3 outside) same (toroid$4 near3 inside)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 20:57
L94	1	(aspher$4 near3 (out or outside)) same (toroid$4 near3 (inside or in))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:00
L95	1	"6778732".pn. and (aspheric with toroidal)	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2014/02/07 21:00

			EPO; JPO; DERWENT; IBM_TDB			
L96	0	(mirror near3 aperature near3 laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:19
L97	441	(mirror near3 aperture near3 laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:20
L98	30	(mirror near3 between near3 aperture near3 laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:20
L99	6	(mirror near3 aperture near3 laser) and (lidar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:22
L100	9	emit$4 near3 toward near3 mirror near3 aperture	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:23
L101	516	(receiv$4 with (inert near3 gas) with seal$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:29
L102	0	(receiv$4 with (inert near3 gas) with seal$4) and (lidar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:29
L103	39	(receiv$4 with (light or beam) with (inert near3 gas) with seal$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 21:30
L104	1	"7969558".pn. and (laser near3 diode)	US-PGPUB; USPAT;	OR	ON	2014/02/07 21:41

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L105	5	pennecot-gaetan.inv. or droz-pierre-yves.inv. or ulrich-drew.inv. or gruver-daniel.inv. or morriss-zachary.inv. or levandowski-anthony.inv.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/02/07 22:11
S1	12	("20110216304" | "3790277" | "4700301" | "4709195" | "5202742" | "5703351" | "7089114" | "7248342" | "7255275" | "7417716" | "7544945" | "7969558").PN.	US-PGPUB; USPAT	OR	ON	2014/02/05 14:24

EAST Search History (Interference)

<This search history is empty>

2/7/2014 10:17:22 PM
C:\Users\sabraham\Documents\EAST\Workspaces\13971606.wsp

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13971606	PENNECOT ET AL.
	Examiner	**Art Unit**
	SAMANTHA K ABRAHAM	3645

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/07/2014								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	O								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13971606	PENNECOT ET AL.
	Examiner	Art Unit
	SAMANTHA K ABRAHAM	3645

CPC- SEARCHED		
Symbol	Date	Examiner
G01C3/08, G01S17/89, G01S7/4817, G01S17/42, G01C15/002, G01C11/025, G01C15/02, G01C21/30	02/07/2014	SKA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
356	4.01, 3.01, 4.07, 5.01, 5.09, 9, 625	02/07/2014	SKA

SEARCH NOTES		
Search Notes	Date	Examiner
East search	02/07/2014	SKA
NPL search	02/07/2014	SKA
East inventor search	02/07/2014	SKA
CPC search	02/07/2014	SKA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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BIB DATA SHEET

CONFIRMATION NO. 4985

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/971,606	08/20/2013	356	3645	13-873

APPLICANTS

Google Inc., Mountain View, CA, Assignee (with 37 CFR 1.172 Interest);

INVENTORS

Gaetan Pennecot, San Francisco, CA;
Pierre-Yves Droz, Los Altos, CA;
Drew Eugene Ulrich, San Francisco, CA;
Daniel Gruver, San Francisco, CA;
Zachary Morriss, San Francisco, CA;
Anthony Levandowski, Berkeley, CA;

**** CONTINUING DATA ***************************

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
09/09/2013

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /SAMANTHA K ABRAHAM/ Examiner's Signature	☐ Met after Allowance SKA Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	11	20	2

ADDRESS

McDonnell Boehnen Hulbert & Berghoff
LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606
UNITED STATES

TITLE

Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path

FILING FEE RECEIVED		
1900	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

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McDONNEL BOEHNEN
HULBERT & BERGHOFF LLP/GOOGLE INC.
300 SOUTH WACKER DRIVE, SUITE 3100
CHICAGO IL 60606

MAILED
SEP 16 2013
OFFICE OF PETITIONS

Doc Code: TRACK1.GRANT

Decision Granting Request for Prioritized Examination (Track I or After RCE)	Application No.: 13/971,606

1. THE REQUEST FILED 8/20/13 IS **GRANTED**.

The above-identified application has met the requirements for prioritized examination

A. ☒ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination.** The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;
B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims**, or a multiple dependent claim;
C. filing a **request for continued examination**;
D. filing a notice of appeal;
E. filing a request for suspension of action;
F. mailing of a notice of allowance;
G. mailing of a final Office action;
H. completion of examination as defined in 37 CFR 41.102; or
I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to Cheryl Gibson-Baylor at (571)272-3213, Office of Petitions. In his/her absence, calls may be directed to Brian W. Brown, (571)272-5338.

Cheryl Gibson-Baylor
/Cheryl Gibson-Baylor/
[*Signature*]

Petitions Paralegal Specialist
(Title)

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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/971,606	08/20/2013	2877	1900	13-873	20	2

CONFIRMATION NO. 4985

98929
McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

FILING RECEIPT

Date Mailed: 09/10/2013

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Gaetan Pennecot, San Francisco, CA;
Pierre-Yves Droz, Los Altos, CA;
Drew Eugene Ulrich, San Francisco, CA;
Daniel Gruver, San Francisco, CA;
Zachary Morriss, San Francisco, CA;
Anthony Levandowski, Berkeley, CA;

Applicant(s)

Google Inc., Mountain View, CA

Assignment For Published Patent Application

Google Inc., Mountain View, CA

Power of Attorney: The patent practitioners associated with Customer Number 98929

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 09/09/2013
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/971,606**

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

Early Publication Request: No

Title

Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path

Preliminary Class

356

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number
13/971,606

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/971,606	08/20/2013	Gaetan Pennecot	13-873

CONFIRMATION NO. 4985

98929
McDonnell Boehnen Hulbert & Berghoff LLP/Google Inc.
300 South Wacker Drive, Suite 3100
Chicago, IL 60606

POA ACCEPTANCE LETTER

OC000000063669437

Date Mailed: 09/10/2013

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/20/2013.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/laguirre/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (03-13)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Gaetan Pennecot	Nonprovisional Application Number (if known):	
Title of Invention:	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1), the prioritized examination fee set forth in 37 CFR 1.17(c), and if not already paid, the publication fee set forth in 37 CFR 1.18(d) have been filed with the request. The basic filing fee, search fee, examination fee, and any required excess claims and application size fees are filed with the request or have been already been paid.

2. The application contains or is amended to contain no more than four independent claims and no more than thirty total claims, and no multiple dependent claims.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. The executed inventor's oath or declaration is filed with the application. (37 CFR 1.63 and 1.64)

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Richard A. Machonkin/	Date 2013-08-20
Name (Print/Typed) Richard A. Machonkin	Practitioner Registration Number 41,962

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☐ *Total of _____ forms are submitted.

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2013-08-20
First Named Inventor	Gaetan Pennecot
Art Unit	
Examiner Name	
Attorney Docket Number	13-873

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	3790277		1974-02-05	Hogan	
	2	4700301		1987-10-13	Dyke	
	3	4709195		1987-11-24	Hellekson et al.	
	4	5202742		1993-04-13	Frank et al.	
	5	7089114	B1	2006-08-08	Huang	
	6	7248342	B1	2007-07-24	Degnan	
	7	7255275	B2	2007-08-14	Gurevich et al.	
	8	7969558	B2	2011-06-28	Hall	

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	Examiner Name	
	Attorney Docket Number	13-873

	9	5703351		1997-12-30	Meyers	
	10	7417716	B2	2008-08-26	Nagasaka et al.	
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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2013-08-20
First Named Inventor	Gaetan Pennecot
Art Unit	
Examiner Name	
Attorney Docket Number	13-873

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Richard A. Machonkin/	Date (YYYY-MM-DD)	2013-08-20
Name/Print	Richard A. Machonkin	Registration Number	41962

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(19) Europäisches Patentamt
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(11) EP 2 410 358 A1

(12) EUROPEAN PATENT APPLICATION

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G02B 6/08 *(2006.01)* ***G02B 6/42*** *(2006.01)*
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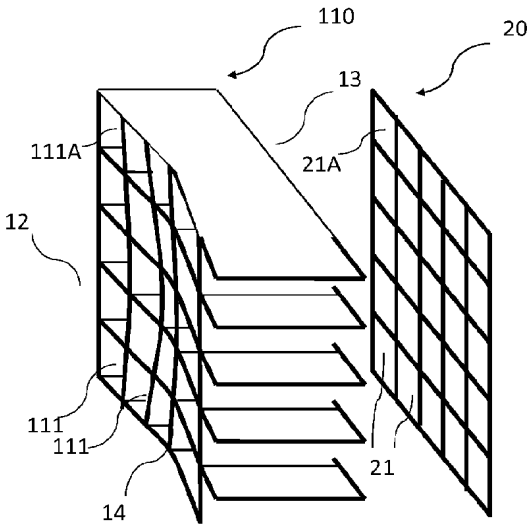
Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) Imaging optics and optical device for mapping a curved image field

(57) The present invention relates to optical devices for imaging and spectroscopic applications where optical field curvature is a predominant characteristic. In particular, the invention relates to imaging optics and an optical device for mapping a curved image field. The optical device for mapping a curved image field comprises a focal plane array 20 having a plurality of light processing elements 21 and a focal plane adapter 110 mounted in front of the focal plane array 20 configured to transmit the curved image field to the light processing elements 21 of the focal plane array 20. The focal plane adapter 110 comprises a plurality of waveguides 111 wherein first ends of the waveguides 111 facing the incident curved image field are arranged on a curved surface 12, the curved surface 12 being adapted to a profile of an optical field curvature of the curved image field so that the plurality of waveguides 111 divide the curved image field along a curved focal plane of the image field into a plurality of image segments. The second ends of the waveguides 111 are allocated to the light processing elements 21 to map the plurality of image segments onto the allocated light processing elements 21.

Fig. 1



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EP 2 410 358 A1

Description

[0001] The present invention relates to optical components for imaging and spectroscopic applications where optical field curvature is a predominant characteristic. In particular, the invention relates to imaging optics and an optical device for mapping a curved image field.

[0002] A particular, but non-exhaustive, application of the invention lies in space missions where optical field curvature is a predominant characteristic. Optical instruments such as telescopes, spectral imaging devices or dispersive spectrometers as often used for space missions have a non planar image field and thus, curved focal plane. Thus, an object is imaged or projected on a curved surface in the image space rather than on a plane due to the optical field curvature. This means that on certain areas in the image plane the local focal length differs from the nominal focal length, the nominal focal length usually being the paraxial focal length. If a curved image field is mapped directly onto a planar focal plane array, the effect of the optical field curvature causes a degradation of the image resolution and image quality of an imaging system or a degradation of the spectral resolution of a dispersive spectrometer.

[0003] A proposed solution in the prior art is to correct for the effect of such a local defocus using compensating optical elements, e.g. a combination of lenses, to "flatten" the curved image field before it is being mapped onto a planar focal plane array (FPA). In general, such optical field correctors consist of corrective lens assemblies that can typically effect a correction of the image plane only in a limited region over the field of view. Moreover, the need for additional field correctors complicates the optical system design and results in higher cost. For example, US 2005/0052751 discloses a microlens array on a curved surface to change the beam curvature to adjust a flat FPA to a curved incoming field. This proposed solution suffers from high weight and volume and is difficult and costly to design and manufacture since the focal length of the microlenses is varying over the array. The proposed microlens array also reduces the throughput since a significant part of the light incident on the curved array is not transmitted via the micro-lenses to the FPA.

[0004] Instead of using corrective lenses in combination with a planar FPA, another approach proposed in the prior art is to fabricate curved FPAs, e.g., by mounting the detectors individually on a curved substrate (mosaicing), as proposed in EP 1122791 B1, which results in a large focal plane array since an individually produced detector including its package is much larger than a detector pixel in a detector array. Another approach is to fabricate detector arrays on a curved surface or to fabricate detector arrays onto a very thin and flexible surface, cf. e.g. Rim et al. (The optical advantages of curved focal plane arrays), Vol. 16, No. 7, Optics Express 4965, 31 March 2008 and Swain et al. (Curved CCD's and Their Applications with Astronomical Telescopes and Stereo Panoramic Cameras), Proc. Of SPIE-IS&T Electronic Imaging, SPIE Vol. 5301, 2004. However, there are no practical, low-cost techniques to realize such curved FPAs. Furthermore, such mo-saiced focal planes are mainly applicable to very large telescopes and are either very expensive and/or have lower performances than solutions based on mass produced conventional detector technology which requires a planar design of the FPA.

[0005] In view of the above problems of the prior art, it is therefore an object of the invention to provide a more compact, simpler and lower-cost optical device to map a curved image field and to reduce the effects of the optical aberrations resulting from the optical field curvature.

[0006] This object is accomplished by the subject-matter according to the optical device of claim 1. The dependent claims refer to preferred embodiments of the invention.

[0007] An optical device for mapping a curved image field, thus an optical device for use in imaging optics for a non planar image field is proposed. In particular, an optical device that guides a curved image field and reduces the effects of optical field curvature of the curved image field is proposed.

[0008] According to an aspect of the invention, the optical device comprises a focal plane array (FPA) having a plurality of light processing elements and a focal plane adapter mounted in front of the FPA and configured to transmit the curved image field to the light processing elements of the FPA.

[0009] An FPA is an image sensing or image processing device consisting of an optical array function volume, i.e., an array, typically rectangular, of light processing elements. An FPA is typically placed at or near a focal plane of the imaging optics. The term "FPA" can refer to a variety of imaging device types that are sensitive in the visible and/ or non-visible spectrum. FPAs can be used for imaging purposes (e.g. taking pictures or video imagery), but can also be used for non-imaging purposes such as spectrometry, LIDAR, and wave-front sensing. The terms "image", "image field" or "FPA" is to be understood in the context of this invention as to also include such "non-imaging" purposes and FPAs, e.g. curved image fields detected with spectrometers.

[0010] According to an aspect of the invention, the FPA may contain a photo-detector array or a microlens array or a liquid crystal array, filters or bolometer array or other means with an optical array function volume. According to another aspect of the invention, the FPA may comprise a CCD or CMOS detector array. According to an aspect of the invention, the FPA may be a planar focal plane array so that a mass-produced focal plane array can be used.

[0011] According to a further aspect of the invention, the focal plane adapter comprises a plurality of waveguides, wherein first ends of the waveguides facing the incident curved image field are arranged on a curved surface, the curved surface being adapted to a contour or profile of an optical field curvature of the curved image field so that the plurality

of waveguides divide the curved image field along a curved focal plane of the image field into a plurality of image segments. In other words, the first ends of the waveguides, i.e., the front side of the hollow waveguide array at the side of the incident light, may be curved so that the focal plane adapter is configured to work as a focal plane sampling element that "pixilates" the curved optical field along the curved focal plane before it reaches the focal plane array to improve the image quality. Thus, the focal plane adapter may have a curved front surface. By way of example, this curvature may correspond to the curvature that would have otherwise been used for the curvature of a curved FPA, e.g. curved CCDs as known from the prior art. This front surface may be concave. The focal plane adapter with a curved front side serves as a focal plane pixilation element capable of guiding the incident light to a predetermined element or a plurality of predetermined elements of the planar focal plane array, thereby reducing the effects of field curvature. The image segments can also be understood as the image "pixels" of the image field that are guided to or mapped onto the array elements of the FPA. Each waveguide has a first end at the side of the incident light, and a second end adjacent to the FPA.

[0012] According to a further aspect of the invention, the second ends of the waveguides are allocated to the light processing elements of the FPA to map the plurality of image segments onto the allocated light processing elements. In other words, the focal plane adapter array is aligned with respect to the FPA by aligning the grid structure of the focal plane adapter to the grid or array structure of the FPA so that one waveguide/grid element of the focal plane adapter may transmit light to one or several predetermined array elements of the FPA. Thus, each waveguide may guide the incident light to a predetermined area of the FPA. The focal plane adapter compensates differing curvatures of the image field and of the FPA by establishing a relationship with an image segment of the curved image plane and the one or several corresponding array element(s) of the FPA to which this image segment is mapped by means of the focal plane adapter, thereby reducing the effect of field curvature on the local defocus or image resolution.

[0013] According to a further aspect of the invention, the curved front surface may be an elliptical paraboloid, or preferably the curved front surface may be a circular paraboloid to adapt the shape of the focal plane adapter front surface to the contour of the optical field curvature of the incident image field.

[0014] According to a further aspect of the invention, the fill factor of the focal plane adapter may be substantially the same as the fill factor of the focal plane array.

[0015] According to a further aspect of the invention, the image segments of the curved image plane may be mapped onto the allocated light processing elements using specular reflection or total internal reflection, only. The focal plane adapter may be an optical waveguide array working on the principle of total internal reflection that doesn't require any optical power, and hence doesn't need optical functionalities of lenses for instance to map a curved image field with a different curvature or by focusing onto a planar FPA or to an FPA. Thus, the focal plane adapter may guide the incident light by means of reflection only, e.g. using waveguides. The focal plane adapter is thus capable of correcting for the effect of the local defocus of the non-planar imaging field without additional functionality than guiding light through waveguides with constant cross section. The focal plane adapter avoids the need of optical functions with optical power (lenses for instance) in front of the FPA.

[0016] According to a further aspect of the invention, the focal plane adapter may be a hollow waveguide array which is a compact, simple, light-weight and low-cost optical component to reduce the effects of the optical aberrations resulting from the optical field curvature of a non-planar image field. As an example, the plurality of waveguides may have a depth in the range of hundreds of micrometers and comprising walls with a light reflective coating and a thickness of a few micrometers.

[0017] A hollow wave guide array in the context of this invention may also include a waveguide grid, i.e., a grid of reflectors with a curved front surface that pixilates the incident light so that the light entering a grid element of the reflector grid is transmitted to one or several corresponding "pixels" or light processing elements of the focal plane array. In other words, the focal plane adapter or the hollow waveguide array may take the form of a curved waveguide sheet or a wafer (e.g. a silicon wafer) with a grid structure that matches, matches partially or not at all, a grid structure of the adjacent grid structure of the FPA. According to a further aspect of the invention, the waveguide array may take the form of a curved plate and may be thought of as conduits that transmit electromagnetic energy from a first end of the waveguide to a second end of the waveguide.

[0018] According to a further aspect of the invention, the waveguide array may be a bundle of substantially parallel electromagnetic waveguides which are held together into a single assembly. Each waveguide may be fused, bonded or otherwise held rigidly to adjacent waveguides.

[0019] According to a further aspect of the invention the focal plane adapter may be a waveguide array wherein the waveguides are not hollow and wherein the distance between adjacent waveguides may be at least two wavelengths and wherein a front and/ or back side of the waveguides may comprise an anti-reflective coating and the side walls of the waveguides may comprise a reflective coating.

[0020] According to another aspect of the invention, the focal plane adapter with a curved front surface wherein the optical waveguides may be embedded in a transparent material (or in air or a vacuum) with index of refraction lower than index of refraction of the waveguide, wherein the length of the optical waveguides may vary from the inner to the

outer portions due to the curved front surface. The waveguides may be formed in straight lines or may be curved. The curvature of the waveguides may vary depending on the curvature of the curved front surface or on design needs of the focal plane adapter.

[0021] According to a further aspect of the invention, the hollow waveguides may have a square cross-section. However, the hollow waveguides may also have a non-square cross-section, such as for example, rectangular or hexagonal cross-sections and may also have varying geometries and dimensions throughout the array. Preferably, the waveguides have the same cross-section as the focal plane array elements.

[0022] Preferably, the second end of the hollow waveguide array, i.e., the end portions of the waveguides that are adjacent to the focal plane array, is planar. A planar shape of the second end is particular advantageous if a planar FPA is used. Other shapes of the second end are also possible.

[0023] According to a further aspect of the invention, the image processing elements of the focal plane array and the plurality of waveguides of the hollow waveguide array may be arranged in a two-dimensional array. According to a further aspect of the invention, these elements may also be arranged in a one-dimensional array. A one-dimensional array may be preferably used if the optical system/instrument including the invention is a spectrometer based on a dispersive element such as a grating for instance.

[0024] According to a further aspect of the invention, an isolation layer or a gap may be arranged between the hollow waveguide array and the focal plane array to protect the often very fragile hollow waveguide array from being damaged during mounting as well as to protect the sensitive FPA, e.g. detector array, from being damaged during mounting or from functional degradation during operation. The gap or isolation layer may also be required by the fact that neither the FPA nor the focal plane adaptor interface surface would have a perfectly matched or flat surface. The hollow waveguide array may also be electrically connected in order to control its voltage.

[0025] According to a further aspect, the hollow waveguide array may comprise a highly light-reflective coating to minimize the losses when guiding the light to the focal plane array. By way of example, the plurality of waveguides may have a depth of hundreds of micrometers and comprise walls with a thickness of only a few micrometers. The dimensions of the waveguide array are preferably chosen depending on the dimensions and array structure of the FPA.

[0026] The present invention is particularly suitable for use in an imaging optics or front optics of imaging devices adapted to a broad field of view, e.g. on-vehicle cameras for detecting obstacles or space telescopes. According to a further aspect of the invention, the optical device of the invention may also be used with a camera objective or, preferably, a wide-field camera objective.

[0027] From the above, it can be understood that the invention solves a very critical optical imaging performance problem of optical instruments based on detector arrays or other FPAs used to process light of a non planar image field. The present invention makes it possible to provide optical instruments such as cameras, telescopes, spectrometers of higher image performance but without any corresponding excessive increase in effort by reducing the complexity, volume and weight of the imaging optics. Combining an FPA that is preferably planar with a focal plane adapter of the invention reduces image degradation resulting from the effects of the optical field curvature and avoids the need for complicated optical elements to change the beam curvature in front of the FPA as well as the need for a curvature of the FPA itself, thereby enabling a simple, cost effective optical device with a high fill factor that effectively avoids the effects of the optical distortions when guiding light with a non-planar image field to the FPA.

[0028] It is a particular advantage of the invention that the focal plane adapter spatially samples the optical field at its best local focus, i.e. along the curved image plane and without cross-sensitivity, to reduce the typical effect of the non-planar optical field which is a wider image point, or which is a local defocus that may degrade the image resolution on the FPA. It is a further advantage that the invention further increases design options for imaging optics by providing the optical design engineer with a new degree of freedom or a variable design parameter. The invention thereby increases the performance of optical systems as well as helping to find easier the optimal solution since corrective lenses and mirrors as required in optical systems known from the prior art can be removed and replaced by a focal plane adapter, such as a thin waveguide grid, in front of the focal plane array, thereby saving mass and volume.

[0029] It should be clear that the invention is not restricted to space applications. The invention finds applications in numerous other fields. Optical devices according to this invention may also be used to increase the imaging performance of optical instruments, in particular of wide field cameras, as used for portable devices such as mobile phones, mobile platforms such as vehicles and air-crafts, in surveillance, robotic vision or industrial monitoring applications. The present invention allows to greatly simplifying the optical design by means of the focal plane adapter as described above. Spectrometers based on optical gratings also can benefit from this invention the spectral resolutions of which can be increased, e.g., without increasing their size, or adding a mirror or a lens.

[0030] The invention is explained below in an exemplary manner with reference to the accompanying drawings, wherein

Fig. 1 illustrates a schematic perspective view of the optical device according to an embodiment of the invention;

Fig. 2A and Fig. 2B illustrate the technical effect of a hollow waveguide array mounted in front of a planar focal plane array;

Fig. 3 illustrates a schematic sectional front view of an optical device according to an embodiment of the present invention;

Fig. 4A and Fig. 4B illustrate schematically an optical device comprising a one-dimensional hollow waveguide array according to an embodiment of the present invention.

[0031] Fig. 1 shows schematically an optical device 1 according to an embodiment of the invention comprising a focal plane array 20 and a hollow waveguide array 110 mounted in front of the focal plane array 20. The focal plane array 20 is planar and comprises a plurality of light processing elements 21 arranged in a two-dimensional pattern. The light processing elements are for example detector pixels, if the focal plane array is a photo detector array. The hollow waveguide array 110 comprises a plurality of waveguides 111, each waveguide 111 corresponding to a light processing element 21 of the focal plane array 20 and transmitting incident light at a first end of the waveguide 111 to the corresponding light processing element 21 of the focal plane array. The first end, i.e., the front side 12, of the hollow waveguide array 110 is curved so that the first ends of the waveguides 111 lie on a curved focal surface. The curved focal surface 12 is adapted to a contour of an optical field curvature of the curved image field and is shaped as an elliptical paraboloid. The plurality of waveguides 111 divide or sample the curved image field along a curved focal plane of the image field into a plurality of image segments or "pixels" as determined by the grid structure of the hollow waveguide array.

[0032] The second ends of the waveguides 111 are located on top of the light processing elements 21 to map the plurality of image segments onto the allocated light processing elements 21. The back side of the focal plane adapter 13 is planar and adjacent to the FPA 20. The insides of the hollow waveguides 111 are reflective, i.e., represent a mirror in order to conduct incident light at the first end 12 to the second end 13 with minimized transmission losses.

[0033] The grid structures of the hollow wave guide array 110 and the grid structure of the focal plane array 20 are aligned, i.e., each waveguide 111 corresponds to a corresponding light processing element 21 of the focal plane array so that light exiting a waveguide and corresponding to a defined image segment of the curved image field hits a well-defined corresponding grid element 21 of the focal plane array 20. For example, the upper left waveguide 111A corresponds to the upper left light processing element 21A as shown in Fig. 1. In other words, all the light entering the waveguide 111A at the first end is transmitted to the corresponding light processing element 21A.

[0034] The hollow waveguide array 110 can be mounted directly onto the focal plane array or at a predetermined small distance or gap in front of the focal plane array 20. As an option, an isolation layer (not shown) separates the hollow waveguide array 110 and the focal plane array 20. Preferably, the distance between the focal plane array 20 and the hollow waveguide array 110 is chosen to be small enough so that all the light exiting from a waveguide 111 mostly hits the corresponding light processing element 21 of the focal plane array 20 and puts limitations on hitting any other light processing element 21. In this way, the hollow waveguide array 110 works as a focal plane (image) "pixilator" or sampler without or with very limited cross-sensitivity. The curved front surface of the hollow waveguide array 110 ensures that pixilation occurs in the (non-planar) focal plane of the optical device, e.g. the telescope. The hollow waveguide array 110 can also be described as a reflector grid placed in front of the focal plane array 20. In order to more clearly emphasize the principle of the invention, holding means used to mount and secure the focal plane adapter 110 in front of the focal plane array 20 are not shown.

[0035] By way of example, such a hollow waveguide array 110 can be manufactured with micromachining techniques, for example, using a deep reactive ion etching (DRIE) process on a silicon substrate which is then coated with a reflective coating to reduce the transmission losses of the waveguide since a waveguide array 110 according to the invention uses internal reflection to transmit the incident electromagnetic energy from one end of the waveguide array to the other end of the waveguide array. The eventual roughness induced by the DRIE process can be reduced with a wet or/and dry process prior to the reflective coating. Depending on the needs and the particular usage scenarios, additional reinforcement structures and alignment structures for simplifying bonding or packaging can be added to the hollow waveguide array structure. The hollow waveguides 111 as shown in Fig. 1 have a square cross-section.

[0036] The effect of the hollow waveguide array is further explained schematically in Figs. 2A and 2B.

[0037] Fig. 2A shows a schematic side view of a conventional flat photo detector array as a typical example of a planar FPA 20, e.g. an FPA of a telescope. Fig. 2B shows a side of view of the same photo detector array of Fig. 2A, however with an additional hollow waveguide array 110 mounted in front of the focal plane array 20. The FPA 20 comprises a number of light processing elements 21, e.g. the photo detector pixels. The focal planes of most telescopes are not flat. Off-axis light usually focuses closer to the objective than does on-axis light. Thus, an object is imaged or projected on a curved surface in the image space rather than on a plane due to the optical field curvature. This optical field curvature is shown schematically using the dotted line 30 which illustrates the resulting curved image plane.

[0038] Since imaging detectors (CCDs, film, etc.) are normally flat, a curved focal plane cannot coincide exactly with

the detector. In particular for large CCD chips and highly curved fields, it will be impossible to correctly image small, sharp stars across the entire field.

[0039] Due to the curved focal plane 30 of the image field, image degradation occurs in that not all light rays 31 hit the corresponding detector element. As illustrated schematically by the dotted circle in Fig. 2A around the lowest light processing element 21 of the focal plane array 20, the optical field of the lowest the light ray 31 enters not only the lowest light processing element 21, but also hits the adjacent light processing element 21 above due to the curved focal plane of the incident light. This distortion effect can be effectively prevented by placing the curved hollow waveguide array 110 in front of the focal plane array 20 as depicted in Fig. 2B which ensures that the lowest light ray 31 only enters the lowest waveguide 111 of the waveguide array 110 and therefore is guided only to the lowest light processing element 21 of the focal plane array 20.

[0040] As illustrated in Fig. 2B, the outer end portions of the wave guides 111 at the side of the incident light lie on a curved surface. The reflector grid or hollow waveguide array has a curved front surface that matches the contour of the optical field curvature of the image plane which allows for compensating for the degradation induced by the curvature difference between the focal plane and the flat focal plane array. Thus, in order to preserve the information being transmitted by the waveguides 111, the relative position of the first ends 12 of each waveguide 111 may be placed substantially in a curved focal plane corresponding to the curved focal plane 30 of the incident light so that he focal plane adapter spatially samples the optical field at its best local focus, i.e., at the curved image plane and without cross-sensitivity to reduce the effect of the non-planar wavefront which is a wider image point, or which is a local defocus that may degrade the image resolution on the FPA. The relative position of the second ends 13 of each waveguide 111 lie in a second planar plane parallel to the plane of the focal plane array 20, wherein each second end portion of a waveguide lies directly adjacent to a corresponding array element 21 of the FPA 20.

[0041] Fig. 3 illustrates a schematic sectional front view of an optical device according to another embodiment of the present invention. According to this embodiment, the focal plane adapter 310 depicted in Fig. 3 comprises optical waveguides with a refractive index higher than 1 or higher than the surrounding media. The surrounding material is either air/vacuum or a transparent material with index of refraction lower than the refractive index of the waveguide.

[0042] The focal plane adapter 310 that is shown in a sectional view in Fig. 3 has a two-dimensional-curved front surface of elliptical paraboloid shape. The back side that is adjacent to the focal plane array 20 is planar. In contrast to the embodiment depicted in Fig. 1, the waveguides 311 are not hollow but have a refractive index higher than the surrounding material causing total internal reflection and thus guiding light with minimal transmission losses to the focal plane array 20. In particular, the optical waveguides 311 guide the light to dedicated sensor elements 21 of the focal plane array 20. Thus, the incident light exiting the optical waveguides 311 hits a predetermined area where the light is further processed. The length of the optical waveguides 311 is increasing from the inner to the outer portions of the front surface due to the concave curvature of the front surface. Whereas the waveguides in the center of the focal plane adapter 310 can be substantially straight, the waveguides 311 at the outer portions of the focal plane adapter 310 are either curved or inclined. The refractive index of the material 315 is higher than that of the optical waveguides 311.

[0043] Fig. 4A illustrates another embodiment of the present invention, wherein the focal plane array 20 and the plurality of waveguides 11 are arranged in a one-dimensional array. Fig. 4A further illustrates schematically the use of a spectrometer device. The incident light enters the spectrometer slit 450 and hits a curved optical grating 460 which splits and diffracts light into several beams travelling in different directions depending on the wavelength of the light. This phenomenon is illustrated in Fig. 4A using three different wavelengths $\lambda 1$, $\lambda 2$, and $\lambda 3$ that are diffracted in different directions with a curved image field. The dotted line 430 is used to illustrate the diffracted curved image plane. An optical device comprising a hollow waveguide array 410 and a focal plane array 20, e.g. a photo detector array, is placed in the propagation direction of these diffracted beams of different wavelength. The optical device according to this embodiment, i.e., a one-dimensional array hollow waveguide array 410 is illustrated in more detail in Fig. 4B which shows the hollow waveguides 411 arranged in a one-dimensional array with a curved front surface at the side of the incident light. The curvature of the front surface is adapted to the curvature of the curved image plane 430. The planar back side of the focal plane array is arranged on top of a focal plane array 20 in the form of a photo detector array.

[0044] Features, components and specific details of the structure of the above-described embodiments may be exchanged or combined to form further embodiments optimized for the respective application. As far as those modifications are already apparent for an expert skilled in the art, this shall be disclosed implicitly by the above description without specifying explicitly every possible combination, for the sake of conciseness of the present description.

Claims

1. An optical device for mapping a curved image field, comprising

- a focal plane array (20) having a plurality of light processing elements (21); and

- a focal plane adapter (110; 310; 410) mounted in front of the focal plane array (20) configured to transmit the curved image field to the light processing elements (21) of the focal plane array (20);

characterized in that

the focal plane adapter (110; 310; 410) comprises a plurality of waveguides (111; 311; 411),
wherein first ends of the waveguides (111; 311; 411) facing the incident curved image field are arranged on a curved surface (12), the curved surface (12) being adapted to a profile of an optical field curvature of the curved image field so that the plurality of waveguides (111; 311; 411) divide the curved image field along a curved focal plane of the image field into a plurality of image segments; and
wherein second ends of the waveguides (111; 311; 411) are allocated to light processing elements (21) to map the plurality of image segments onto the allocated light processing elements (21).

2. An optical device according to claim 1, wherein the curved focal surface (12) is an elliptical paraboloid.

3. An optical device according to claim 1, wherein the image segments of the non-planar/curved image plane are mapped onto the allocated light processing elements (21) using specular reflection.

4. An optical device according to at least of one of the claims 1 -3, the focal plane adapter being a hollow waveguide array (110).

5. An optical device according to claim 1, the focal plane adapter being an optical waveguide array working on the principle of total internal reflection (310).

6. An optical device according to claims 1 and 5, the optical waveguides (311) being embedded in a substantially transparent material or air/vacuum with a refractive index lower than the refractive index of the waveguides (311) of the focal plane adapter (310), the focal plane adapter (310) having a curved front surface, and wherein the length of the optical waveguides (311) is varying from the inner to the outer portions of the front surface.

7. An optical device according to any of claims 1, 2, 5 or 6 the focal plane adapter (310) being an optical waveguide array working on the principle of total internal reflection, wherein the distance between adjacent waveguides (311) is at least two wavelengths and wherein a front or/and back side of the waveguides comprises an anti-reflective coating.

8. An optical device according to at least one of the preceding claims 1 to 3, the plurality of waveguides (111) having a depth in the range of hundreds of micrometers and comprising walls (14) with a light reflective coating and a thickness of a few micrometers.

9. An optical device according to at least one of the preceding claims, the focal plane array (20) being a planar focal plane array.

10. An optical device according to at least one of the preceding claims, the focal plane array (20) comprising a photo-detector array, or a microlens array, or a liquid crystal array.

11. An optical device according to at least one of the preceding claims, further comprising an isolation layer or gap being arranged between the focal plane adapter (110; 310; 410) and the focal plane array (20).

12. An optical device according to at least one of the preceding claims, the image processing elements (21) of the focal plane array (20) and the plurality of waveguides (111; 311) of the focal plane adapter (110; 310) being arranged in a two-dimensional array.

13. An optical device according to at least one of the preceding claims, the image processing elements (21) of the focal plane array (20) and the plurality of waveguides (411) of the focal plane adapter(410) being arranged in an one-dimensional array.

14. An imaging spectrometer comprising one or several devices according to claims 12 or 13.

15. A spectrometer comprising one or several devices according to claims 12 or 13.

16. A wide field camera comprising one or several devices according to any of the preceding claims 1-13.

17. A telescope comprising one or several devices according to any of the preceding claims 1-13.

Amended claims in accordance with Rule 137(2) EPC.

1. An optical device for mapping a curved image field, comprising

- a focal plane array (20) having a plurality of light processing elements (21); and
- a focal plane adapter (110; 310; 410) mounted in front of the focal plane array (20) configured to transmit the curved image field to the light processing elements (21) of the focal plane array (20); the focal plane adapter (110; 310; 410) comprises a plurality of waveguides (111; 311; 411),

wherein first ends of the waveguides (111; 311; 411) facing the incident curved image field are arranged on a curved surface (12), the curved surface (12) being adapted to a profile of an optical field curvature of the curved image field so that the plurality of waveguides (111; 311; 411) divide the curved image field along a curved focal plane of the image field into a plurality of image segments; and
wherein second ends of the waveguides (111; 311; 411) are allocated to light processing elements (21) to map the plurality of image segments onto the allocated light processing elements (21)
characterized in that
the focal plane adapter being a hollow waveguide array (110).

2. An optical device according to claim 1, wherein the curved focal surface (12) is an elliptical paraboloid.

3. An optical device according to claim 1, wherein the image segments of the non-planar/curved image plane are mapped onto the allocated light processing elements (21) using specular reflection.

4. An optical device according to at least one of the preceding claims 1 to 3, the plurality of waveguides (111) having a depth in the range of hundreds of micrometers and comprising walls (14) with a light reflective coating and a thickness of a few micrometers.

5. An optical device according to at least one of the preceding claims, the focal plane array (20) being a planar focal plane array.

6. An optical device according to at least one of the preceding claims, the focal plane array (20) comprising a photo-detector array, or a microlens array, or a liquid crystal array.

7. An optical device according to at least one of the preceding claims, further comprising an isolation layer or gap being arranged between the focal plane adapter (110; 310; 410) and the focal plane array (20).

8. An optical device according to at least one of the preceding claims, the image processing elements (21) of the focal plane array (20) and the plurality of waveguides (111; 311) of the focal plane adapter (110; 310) being arranged in a two-dimensional array.

9. An optical device according to at least one of the preceding claims, the image processing elements (21) of the focal plane array (20) and the plurality of waveguides (411) of the focal plane adapter(410) being arranged in an one-dimensional array.

10. An imaging spectrometer comprising one or several devices according to claims 8 or 9.

11. A spectrometer comprising one or several devices according to claims 8 or 9.

12. A wide field camera comprising one or several devices according to any of the preceding claims 1-9.

13. A telescope comprising one or several devices according to any of the preceding claims 1-9.

Fig. 1

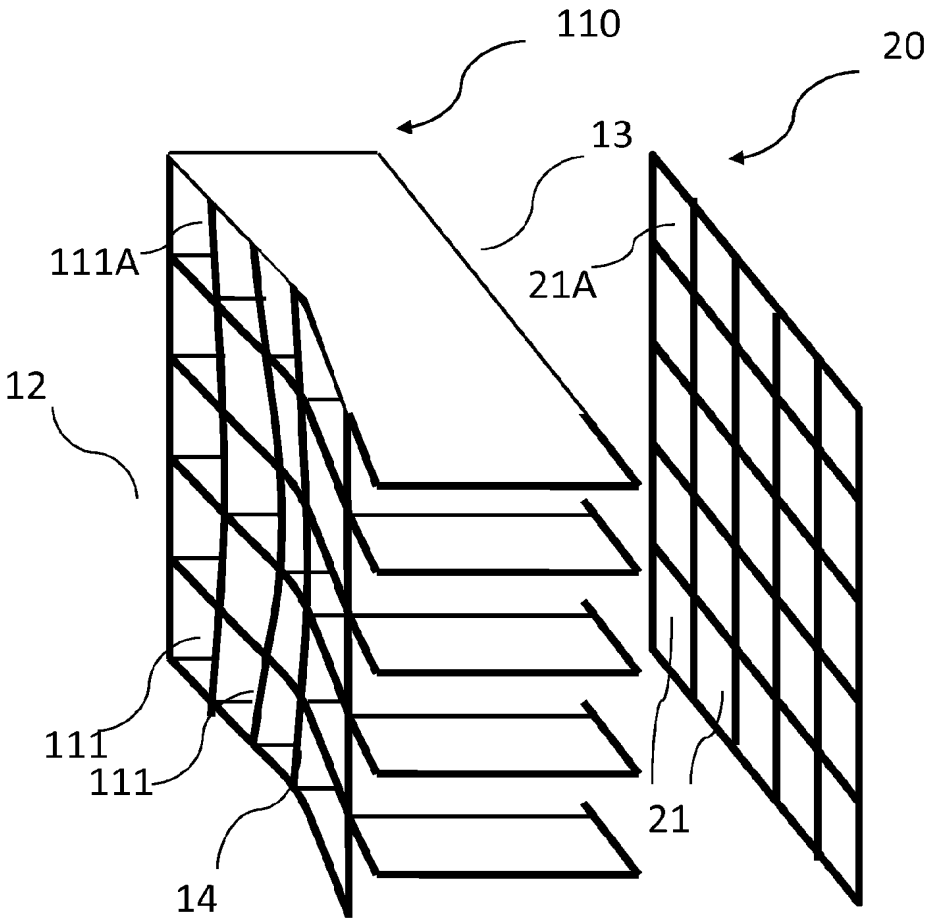

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Fig. 2A

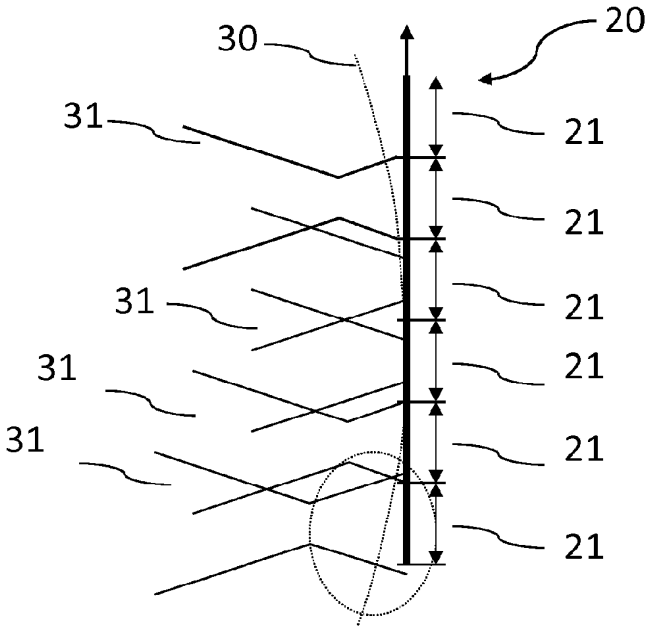
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Fig. 2B

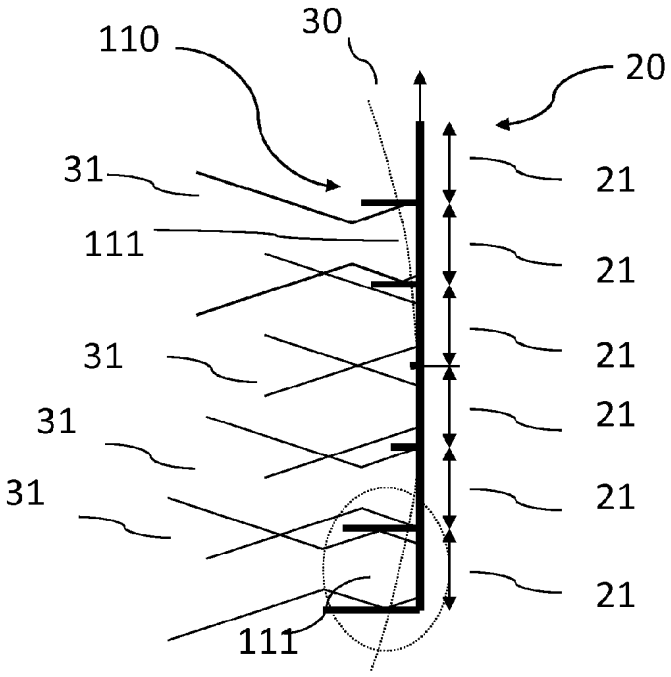
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Fig. 3

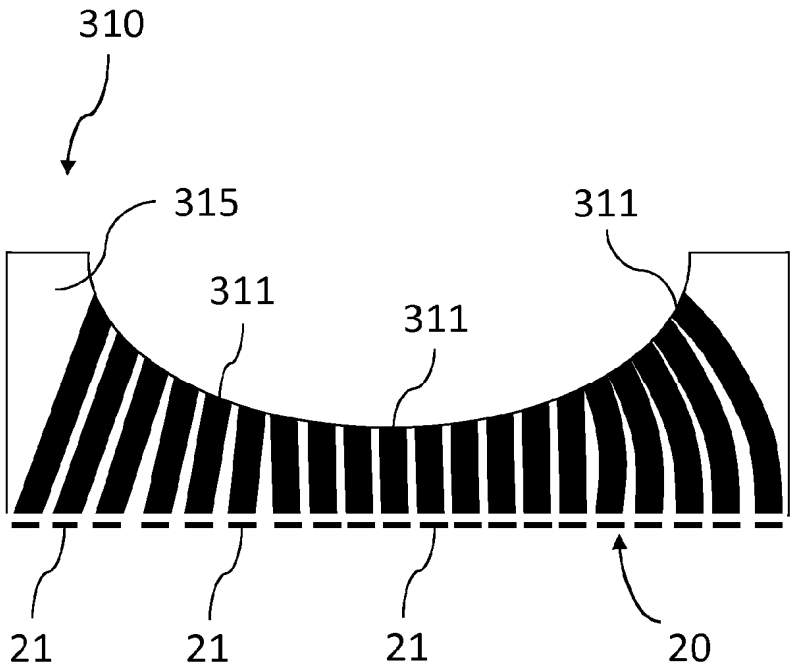

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Fig. 4A

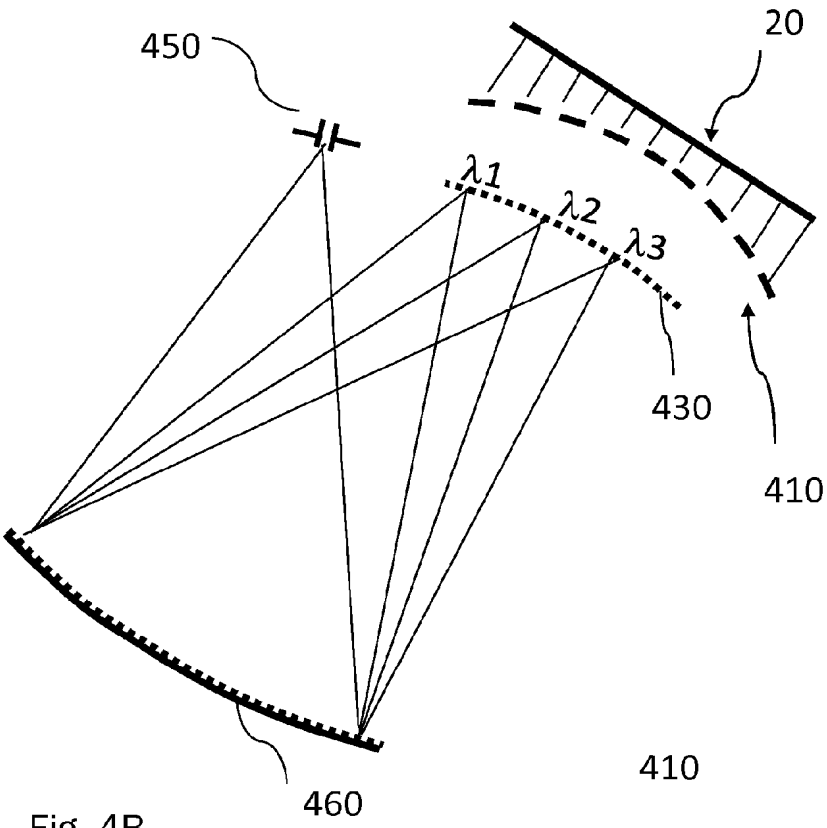
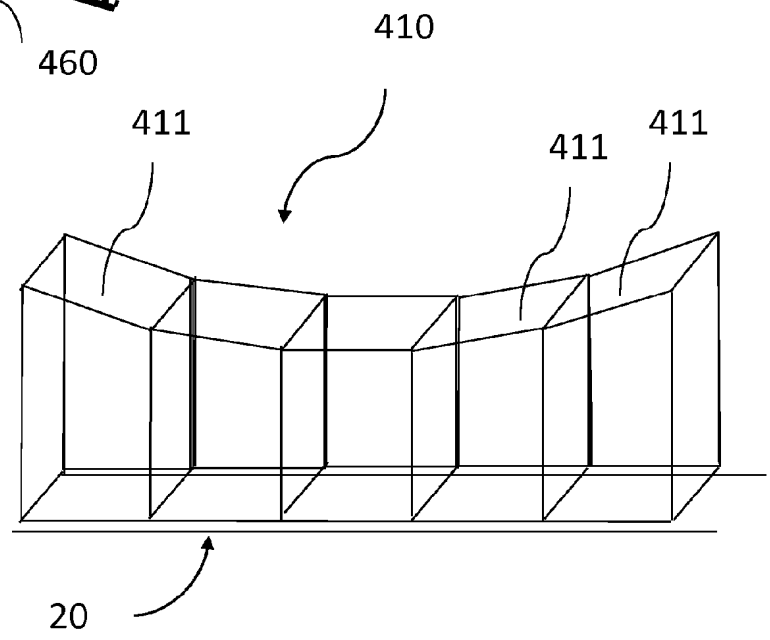


Fig. 4B



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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 0040

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2005/050558 A2 (UNIV WASHINGTON [US]) 2 June 2005 (2005-06-02) * page 29 - page 30; figures 14-15 *	1,3,5,9, 10,12,13	INV. G02B6/08 G02B6/42 G02B27/00
X	WO 2004/070438 A1 (HONEYWELL INT INC [US]) 19 August 2004 (2004-08-19) * page 38 - page 42; figures 19-22 *	1,6, 14-17	
X	US 7 587 109 B1 (REININGER FRANCIS MARK [US]) 8 September 2009 (2009-09-08) * column 6; figure 1 *	1,9,10, 12,13	

TECHNICAL FIELDS SEARCHED (IPC)

G02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	10 January 2011	Andreassen, Jon

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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1

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 17 0040

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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10-01-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005050558 A2	02-06-2005	NONE	
WO 2004070438 A1	19-08-2004	NONE	
US 7587109 B1	08-09-2009	NONE	

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- EP 1122791 B1 **[0004]**

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- **RIM et al.** The optical advantages of curved focal plane arrays. *Optics Express 4965,* 31 March 2008, vol. 16 (7 **[0004]**
- **SWAIN et al.** Curved CCD's and Their Applications with Astronomical Telescopes and Stereo Panoramic Cameras. *Proc. Of SPIE-IS&T Electronic Imaging, SPIE,* 2004, vol. 5301 **[0004]**

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Gaetan Pennecot Date (Optional): Jul 30, 2013

Signature: /Gaetan Pennecot/

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Pierre-yves Droz Date (Optional): Jul 30, 2013

Signature: /Pierre-Yves Droz/

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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- [x] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Drew Eugene Ulrich Date (Optional): Jul 30, 2013

Signature: /Drew E. Ulrich/

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Daniel Gruver Date (Optional): Jul 30, 2013

Signature: /Daniel Gruver/

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

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LEGAL NAME OF INVENTOR

Inventor: Zachary Morriss Date (Optional): Jul 30, 2013

Signature: /Zachary James Morriss/

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path

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LEGAL NAME OF INVENTOR

Inventor: Anthony Levandowski Date (Optional): Jul 30, 2013

Signature: /Anthony Scott Levandowski/

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/ Receive Path
First Named Inventor/Applicant Name:	Gaetan Pennecot
Filer:	Richard A Machonkin
Attorney Docket Number:	13-873

Filed as Large Entity

Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	280	280
Utility Search Fee	1111	1	600	600
Utility Examination Fee	1311	1	720	720
Request for Prioritized Examination	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Publ. Fee- Early, Voluntary, or Normal	1504	1	300	300
OTHER PUBLICATION PROCESSING FEE	1808	1	130	130

Petition:

Patent-Appeals-and-Interference:

Post-Allowance-and-Post-Issuance:

Extension-of-Time:

Miscellaneous:

Total in USD ($) **6030**

Electronic Acknowledgement Receipt

EFS ID:	16639720
Application Number:	13971606
International Application Number:	
Confirmation Number:	4985
Title of Invention:	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/ Receive Path
First Named Inventor/Applicant Name:	Gaetan Pennecot
Customer Number:	98929
Filer:	Richard A Machonkin
Filer Authorized By:	
Attorney Docket Number:	13-873
Receipt Date:	20-AUG-2013
Filing Date:	
Time Stamp:	18:15:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$6030
RAM confirmation Number	5509
Deposit Account	132490
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	TrackOne Request	13-873_TrackOne_Request.pdf	152679 e615f65422748c79edc6168fdc1100928cd7d2ff	no	2
Warnings:					
Information:					
2	Power of Attorney	13-873_POA.pdf	417845 cdd97824a3507b0d8e2315f8d49851742c2dd32e	no	2
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
3	Application Data Sheet	13-873_Application_Data_Sheet.pdf	1234407 dc1dda819d79ba431791f5a8f73516c142afe780	no	8
Warnings:					
Information:					
4	Nonpublication request from applicant.	13-873_Nonpublication_Request.pdf	234702 82642bf4dcfd7b586e1381f74a2315e860dabb0f	no	2
Warnings:					
Information:					
5		13-873_Specification.pdf	193107 b04533687b1ea13b0b9f047bb3503c85dfe4fd8e	yes	44

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	38
Claims	39	43
Abstract	44	44

Warnings:					
Information:					
6	Drawings-only black and white line drawings	13-873_Drawings.pdf	136233 dd9001f2b70eec00eaf4bf7f50440213d6462045	no	11
Warnings:					
Information:					

7	Information Disclosure Statement (IDS) Form (SB08)	13-873_IDS.pdf	612704 b4554b284df5d4be0781890847f0157d2cfa2a6e	no	5
Warnings:					
Information:					
8	Foreign Reference	EP2410358A1.pdf	762369 b70c55a9d264b6a0810acc923dcf515784c8d3de	no	15
Warnings:					
Information:					
9	Oath or Declaration filed	13-873_Declaration.pdf	693098 5f22266350ccc85a23da214f3ced6f9ac585b2aa	no	6
Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	40219 3852b18726f13239cd0489ab8a92166d33e29b31	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	4477363	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Acknowledgement Receipt

EFS ID:	16639720
Application Number:	13971606
International Application Number:	
Confirmation Number:	4985
Title of Invention:	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/ Receive Path
First Named Inventor/Applicant Name:	Gaetan Pennecot
Customer Number:	98929
Filer:	Richard A Machonkin
Filer Authorized By:	
Attorney Docket Number:	13-873
Receipt Date:	20-AUG-2013
Filing Date:	
Time Stamp:	18:15:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$6030
RAM confirmation Number	5509
Deposit Account	132490
Authorized User	

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Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	TrackOne Request	13-873_TrackOne_Request.pdf	152679 e615f65422748c79edc6168fdc1100928cd7d2ff	no	2
Warnings:					
Information:					
2	Power of Attorney	13-873_POA.pdf	417845 cdd97824a3507b0d8e2315f8d49851742c2dd32e	no	2
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
3	Application Data Sheet	13-873_Application_Data_Sheet.pdf	1234407 dc1dda819d79ba431791f5a8f73516c142afe780	no	8
Warnings:					
Information:					
4	Nonpublication request from applicant.	13-873_Nonpublication_Request.pdf	234702 82642bf4dcfd7b586e1381f74a2315e860dabb0f	no	2
Warnings:					
Information:					
5		13-873_Specification.pdf	193107 b04533687b1ea13b0b9f047bb3503c85dfe4fd8e	yes	44

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	38
Claims	39	43
Abstract	44	44

Warnings:					
Information:					
6	Drawings-only black and white line drawings	13-873_Drawings.pdf	136233 dd9001f2b70eec00eaf4bf7f50440213d6462045	no	11
Warnings:					
Information:					

7	Information Disclosure Statement (IDS) Form (SB08)	13-873_IDS.pdf	612704 b4554b284df5d4be0781890847f0157d2cfa2a6e	no	5
Warnings:					
Information:					
8	Foreign Reference	EP2410358A1.pdf	762369 b70c55a9d264b6a0810acc923dcf515784c8d3de	no	15
Warnings:					
Information:					
9	Oath or Declaration filed	13-873_Declaration.pdf	693098 5f22266350ccc85a23da214f3ced6f9ac585b2aa	no	6
Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	40219 3852b18726f13239cd0489ab8a92166d33e29b31	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	4477363	

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: 98929

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number: 98929

OR

☐	Firm or Individual Name			
	Address			
	City		State	Zip
	Country			
	Telephone		Email	

Assignee Name and Address: Google Inc.
1600 Amphitheatre Parkway
Mountain View, CA 94043

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be Filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	Oct. 30, 2012
Name	Donald Harrison	Telephone	650-253-0000
Title	Vice President, Deputy General Counsel & Assistant Secretary		

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/14 (03-13)
Approved for use through 07/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	13-873
	Application Number	
Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Gaetan		Pennecot	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	San Francisco	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	Google Inc.
Address 2	1600 Amphitheatre Parkway

City	Mountain View	State/Province	CA
Postal Code	94043	Country i	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Pierre-Yves		Droz	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Los Altos	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	Google Inc.
Address 2	1600 Amphitheatre Parkway

City	Mountain View	State/Province	CA
Postal Code	94043	Country i	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Drew	Eugene	Ulrich	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

PTO/AIA/14 (03-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	13-873
	Application Number	
Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path	

City	San Francisco	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	Google Inc.		
Address 2	1600 Amphitheatre Parkway		
City	Mountain View	State/Province	CA
Postal Code	94043	Country i	US

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Daniel		Gruver	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	San Francisco	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	Google Inc.		
Address 2	1600 Amphitheatre Parkway		
City	Mountain View	State/Province	CA
Postal Code	94043	Country i	US

Inventor 5 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Zachary		Morriss	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	San Francisco	State/Province	CA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	Google Inc.		
Address 2	1600 Amphitheatre Parkway		
City	Mountain View	State/Province	CA
Postal Code	94043	Country i	US

Inventor 6 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Anthony		Levandowski	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	Berkeley	State/Province	CA	Country of Residence i	US

PTO/AIA/14 (03-13)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	13-873
	Application Number	
Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path	

Mailing Address of Inventor:

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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

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☐ **An Address is being provided for the correspondence Information of this application.**

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Application Information:

Title of the Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path		
Attorney Docket Number	13-873	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	11	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

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Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

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			Remove
Application Number	Country [i]	Filing Date (YYYY-MM-DD)	Access Code [i] (if applicable)

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

Authorization to Permit Access:

☐ Authorization to Permit Access to the Instant Application by the Participating Offices

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In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

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Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

(•) Assignee	( ) Legal Representative under 35 U.S.C. 117	( ) Joint Inventor
( ) Person to whom the inventor is obligated to assign.	( ) Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. [X]

Organization Name	Google Inc.

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Address 2			
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Country [i]	US	Postal Code	94043
Phone Number		Fax Number	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	13-873
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Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path	

Email Address	

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Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).

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Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

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Address 1	
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Additional Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/Richard A. Machonkin/			Date (YYYY-MM-DD)	2013-08-20
First Name	Richard A.	Last Name	Machonkin	Registration Number	41962

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	13-873
	Application Number	
Title of Invention	Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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NONPUBLICATION REQUEST UNDER 35 U.S.C. 122(b)(2)(B)(i)

First Named Inventor	Gaetan Pennecot
Title	Devices and Methods for a Rotating LIDAR Platf
Attorney Docket Number	13-873

I hereby certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

I hereby request that the attached application not be published under 35 U.S.C. 122(b).

/Richard A. Machonkin/ — Signature

2013-08-20 — Date

Richard A. Machonkin — Typed or printed name

41,962 — Registration Number, if applicable

312-913-0001 — Telephone Number

This request must be signed in compliance with 37 CFR 1.33(b) and submitted with the application **upon filing.**

Applicant may rescind this nonpublication request at any time. If applicant rescinds a request that an application not be published under 35 U.S.C. 122(b), the application will be scheduled for publication at eighteen months from the earliest claimed filing date for which a benefit is claimed.

If applicant subsequently files an application directed to the invention disclosed in the attached application in another country, or under a multilateral international agreement, that requires publication of applications eighteen months after filing, the applicant **must** notify the United States Patent and Trademark Office of such filing within forty-five (45) days after the date of the filing of such foreign or international application. **Failure to do so will result in abandonment of this application (35 U.S.C. 122(b)(2)(B)(iii)).**

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The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

APPLICATION FOR UNITED STATES PATENT
UNITED STATES PATENT AND TRADEMARK OFFICE

MBHB Case No. 13-873

Title: Devices and Methods for a Rotating LIDAR Platform with a Shared Transmit/Receive Path

Inventors: Gaetan Pennecot
Pierre-yves Droz
Drew Eugene Ulrich
Daniel Gruver
Zachary Morriss
Anthony Levandowski

BACKGROUND

[0001] Unless otherwise indicated herein, the materials described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0002] Vehicles can be configured to operate in an autonomous mode in which the vehicle navigates through an environment with little or no input from a driver. Such autonomous vehicles can include one or more sensors that are configured to detect information about the environment in which the vehicle operates.

[0003] One such sensor is a light detection and ranging (LIDAR) device. A LIDAR can estimates distance to environmental features while scanning through a scene to assemble a "point cloud" indicative of reflective surfaces in the environment. Individual points in the point cloud can be determined by transmitting a laser pulse and detecting a returning pulse, if any, reflected from an object in the environment, and determining the distance to the object according to the time delay between the transmitted pulse and the reception of the reflected pulse. A laser, or set of lasers, can be rapidly and repeatedly scanned across a scene to provide continuous real-time information on distances to reflective objects in the scene. Combining the measured distances and the orientation of the laser(s) while measuring each distance allows for associating a three-dimensional position with each returning pulse. In this way, a three-dimensional map of points indicative of locations of reflective features in the environment can be generated for the entire scanning zone.

SUMMARY

[0004] In one example, a light detection and ranging (LIDAR) device is provided that includes a housing configured to rotate about an axis. The housing has an interior space that includes a transmit block, a receive block, and a shared space. The transmit block has an exit aperture and the receive block has an entrance aperture. The LIDAR device also includes a plurality of light sources in the transmit block. The plurality of light sources is configured to emit a plurality of light beams that enter the shared space through the exit aperture and traverse the shared space via a transmit path. The light beams include light having wavelengths in a wavelength range. The LIDAR device also includes a plurality of detectors in the receive block. The plurality of detectors is configured to detect light having wavelengths in the wavelength range. The LIDAR device also includes a lens mounted to the housing. The lens is configured to (i) receive the light beams via the transmit path, (ii) collimate the light beams for transmission into an environment of the LIDAR device, (iii) collect light that includes light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device, and (iv) focus the collected light onto the detectors via a receive path that extends through the shared space and the entrance aperture of the receive block.

[0005] In another example, a method is provided that involves rotating a housing of a light detection and ranging (LIDAR) device about an axis. The housing has an interior space that includes a transmit block, a receive block, and a shared space. The transmit block has an exit aperture and the receive block has an entrance aperture. The method further involves emitting a plurality of light beams by a plurality of light sources in the transmit block. The plurality of light beams enter the shared space via a transmit path. The light beams include light having wavelengths in a wavelength range. The method further involves receiving the light beams at a

lens mounted to the housing along the transmit path. The method further involves collimating, by the lens, the light beams for transmission into an environment of the LIDAR device. The method further involves collecting, by the lens, light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device. The method further involves focusing, by the lens, the collected light onto a plurality of detectors in the receive block via a receive path that extends through the shared space and the entrance aperture of the receive block. The method further involves detecting, by the plurality of detectors in the receive block, light from the focused light having wavelengths in the wavelength range.

[0006] These as well as other aspects, advantages, and alternatives, will become apparent to those of ordinary skill in the art by reading the following detailed description, with reference where appropriate to the accompanying figures.

BRIEF DESCRIPTION OF THE FIGURES

[0007] Figure 1 is a block diagram of an example LIDAR device.

[0008] Figure 2 is a cross-section view of an example LIDAR device.

[0009] Figure 3A is a perspective view of an example LIDAR device fitted with various components, in accordance with at least some embodiments described herein

[0010] Figure 3B is a perspective view of the example LIDAR device shown in Figure 3A with the various components removed to illustrate interior space of the housing.

[0011] Figure 4 illustrates an example transmit block, in accordance with at least some embodiments described herein.

[0012] Figure 5A is a view of an example light source, in accordance with an example embodiment.

[0013] Figure 5B is a view of the light source of Figure 5A in combination with a cylindrical lens, in accordance with an example embodiment.

[0014] Figure 5C is another view of the light source and cylindrical lens combination of Figure 5B, in accordance with an example embodiment.

[0015] Figure 6A illustrates an example receive block, in accordance with at least some embodiments described herein.

[0016] Figure 6B illustrates a side view of three detectors included in the receive block of Figure 6A.

[0017] Figure 7A illustrates an example lens with an aspheric surface and a toroidal surface, in accordance with at least some embodiments described herein.

[0018] Figure 7B illustrates a cross-section view of the example lens 750 shown in Figure 7A.

[0019] Figure 8A illustrates an example LIDAR device mounted on a vehicle, in accordance with at least some embodiments described herein.

[0020] Figure 8B illustrates a scenario where the LIDAR device shown in Figure 8A is scanning an environment that includes one or more objects, in accordance with at least some embodiments described herein.

[0021] Figure 9 is a flowchart of a method, in accordance with at least some embodiments described herein.

DETAILED DESCRIPTION

[0022] The following detailed description describes various features and functions of the disclosed systems, devices and methods with reference to the accompanying figures. In the figures, similar symbols identify similar components, unless context dictates otherwise. The illustrative system, device and method embodiments described herein are not meant to be limiting. It may be readily understood by those skilled in the art that certain aspects of the disclosed systems, devices and methods can be arranged and combined in a wide variety of different configurations, all of which are contemplated herein.

[0023] A light detection and ranging (LIDAR) device may transmit light pulses originating from a plurality of light sources and may receive reflected light pulses that are then detected by a plurality of detectors. Within examples described herein, a LIDAR device is provided that includes a transmit/receive lens that both collimates the light from the plurality of light sources and focuses the reflected light onto the plurality of detectors. By using a transmit/receive lens that performs both of these functions, instead of a transmit lens for collimating and a receive lens for focusing, advantages with respect to size, cost, and/or complexity can be provided.

[0024] The LIDAR device comprises a housing that is configured to rotate about an axis. In some examples, the axis is substantially vertical. The housing may have an interior space that includes various components such as a transmit block that includes the plurality of light sources, a receive block that includes the plurality of detectors, a shared space where emitted light traverses from the transmit block to the transmit/receive lens and reflected light traverses from the transmit/receive lens to the receive block, and the transmit/receive lens that collimates the

emitted light and focuses the reflected light. By rotating the housing that includes the various components, in some examples, a three-dimensional map of a 360-degree field of view of an environment of the LIDAR device can be determined without frequent recalibration of the arrangement of the various components.

[0025] In some examples, the housing may include radio frequency (RF) and optical shielding between the transmit block and the receive block. For example, the housing can be formed from and/or coated by a metal, metallic ink, or metallic foam to provide the RF shielding. Metals used for shielding can include, for example, copper or nickel.

[0026] The plurality of light sources included in the transmit block can include, for example, laser diodes. In one example, the light sources emit light with wavelengths of approximately 905 nm. In some examples, a transmit path through which the transmit/receive lens receives the light emitted by the light sources may include a reflective element, such as a mirror or prism. By including the reflective element, the transmit path can be folded to provide a smaller size of the transmit block and, hence, a smaller housing of the LIDAR device. Additionally, the transmit path includes an exit aperture of the transmit block through which the emitted light enters the shared space and traverses to the transmit/receive lens.

[0027] In some examples, each light source of the plurality of light sources includes a respective lens, such as a cylindrical or acylindrical lens. The light source may emit an uncollimated light beam that diverges more in a first direction than in a second direction. In these examples, the light source's respective lens may pre-collimate the uncollimated light beam in the first direction to provide a partially collimated light beam, thereby reducing the divergence in the first direction. In some examples, the partially collimated light beam diverges less in the

first direction than in the second direction. The transmit/receive lens receives the partially collimated light beams from the one or more light sources via an exit aperture of the transmit block and the transmit/receive lens collimates the partially collimated light beams to provide collimated light beams that are transmitted into the environment of the LIDAR device. In this example, the light emitted by the light sources may have a greater divergence in the second direction than in the first direction, and the exit aperture can accommodate vertical and horizontal extents of the beams of light from the light sources.

[0028] The housing mounts the transmit/receive lens through which light from the plurality of light sources can exit the housing, and reflected light can enter the housing to reach the receive block. The transmit/receive lens can have an optical power that is sufficient to collimate the light emitted by the plurality of light sources and to focus the reflected light onto the plurality of detectors in the receive block. In one example, the transmit/receive lens has a surface with an aspheric shape that is at the outside of the housing, a surface with a toroidal shape that is inside the housing, and a focal length of approximately 120 mm.

[0029] The plurality of detectors included in the receive block can include, for example, avalanche photodiodes in a sealed environment that is filled with an inert gas, such as nitrogen. The receive block can include an entrance aperture through which focused light from the transmit/receive lens traverses towards the detectors. In some examples, the entrance aperture can include a filtering window that passes light having wavelengths within the wavelength range emitted by the plurality of light sources and attenuates light having other wavelengths.

[0030] The collimated light transmitted from the LIDAR device into the environment may reflect from one or more objects in the environment to provide object-reflected light. The

transmit/receive lens may collect the object-reflected light and focus the object-reflected light through a focusing path ("receive path") onto the plurality of detectors. In some examples, the receive path may include a reflective surface that directs the focused light to the plurality of detectors. Additionally or alternatively, the reflective surface can fold the focused light towards the receive block and thus provide space savings for the shared space and the housing of the LIDAR device.

[0031] In some examples, the reflective surface may define a wall that includes the exit aperture between the transmit block and the shared space. In this case, the exit aperture of the transmit block corresponds to a transparent and/or non-reflective portion of the reflective surface. The transparent portion can be a hole or cut-away portion of the reflective surface. Alternatively, the reflective surface can be formed by forming a layer of reflective material on a transparent substrate (e.g., glass) and the transparent portion can be a portion of the substrate that is not coated with the reflective material. Thus, the shared space can be used for both the transmit path and the receive path. In some examples, the transmit path at least partially overlaps the receive path in the shared space.

[0032] The vertical and horizontal extents of the exit aperture are sufficient to accommodate the beam widths of the emitted light beams from the light sources. However, the non-reflective nature of the exit aperture prevents a portion of the collected and focused light in the receive path from reflecting, at the reflective surface, towards the detectors in the receive block. Thus, reducing the beam widths of the emitted light beams from the transmit blocks is desirable to minimize the size of the exit aperture and reduce the lost portion of the collected light. In some examples noted above, the reduction of the beam widths traversing through the exit aperture can be achieved by partially collimating the emitted light beams by including a

respective lens, such as a cylindrical or acylindrical lens, adjacent to each light source.

[0033] Additionally or alternatively, to reduce the beam widths of the emitted light beams, in some examples, the transmit/receive lens can be configured to define a focal surface that has a substantial curvature in a vertical plane and/or a horizontal plane. For example, the transmit/receive lens can be configured to have the aspheric surface and the toroidal surface described above that provides the curved focal surface along the vertical plane and/or the horizontal plane. In this configuration, the light sources in the transmit block can be arranged along the transmit/receive lens' curved focal surface in the transmit block, and the detectors in the receive block can be arranged on the transmit/receive lens' curved focal surface in the receive block. Thus, the emitted light beams from the light sources arranged along the curved focal surface can converge into the exit aperture having a smaller size than an aperture for light beams that are substantially parallel and/or diverging.

[0034] To facilitate such curved arrangement of the light sources, in some examples, the light sources can be mounted on a curved edge of one or more vertically-oriented printed circuit boards (PCBs), such that the curved edge of the PCB substantially matches the curvature of the focal surface in the vertical plane of the PCB. In this example, the one or more PCBs can be mounted in the transmit block along a horizontal curvature that substantially matches the curvature of the focal surface in the horizontal plane of the one or more PCBs. For example, the transmit block can include four PCBs, with each PCB mounting sixteen light sources, so as to provide 64 light sources along the curved focal plane of the transmit/receive lens in the transmit block. In this example, the 64 light sources are arranged in a pattern substantially corresponding to the curved focal surface defined by the transmit/receive lens such that the emitted light beams converge towards the exit aperture of the transmit block.

[0035] For the receive block, in some examples, the plurality of detectors can be disposed on a flexible PCB that is mounted to the receive block to conform with the shape of the transmit/receive lens' focal surface. For example, the flexible PCB may be held between two clamping pieces that have surfaces corresponding to the shape of the focal surface. Additionally, in this example, each of the plurality of detectors can be arranged on the flexible PCB so as to receive focused light from the transmit/receive lens that corresponds to a respective light source of the plurality of light sources. In this example, the detectors can be arranged in a pattern substantially corresponding to the curved focal surface of the transmit/receive lens in the receive block. Thus, in this example, the transmit/receive lens can be configured to focus onto each detector of the plurality of detectors a respective portion of the collected light that comprises light from the detector's corresponding light source.

[0036] Some embodiments of the present disclosure therefore provide systems and methods for a LIDAR device that uses a shared transmit/receive lens. In some examples, such LIDAR device can include the shared lens configured to provide a curved focal plane for transmitting light sources and receiving detectors such that light from the light sources passes through a small exit aperture included in a reflective surface that reflects collected light towards the detectors.

[0037] Figure 1 is a block diagram of an example LIDAR device 100. The LIDAR device 100 comprises a housing 110 that houses an arrangement of various components included in the LIDAR device 100 such as a transmit block 120, a receive block 130, a shared space 140, and a lens 150. The LIDAR device 100 includes the arrangement of the various components that provide emitted light beams 102 from the transmit block 120 that are collimated by the lens 150 and transmitted to an environment of the LIDAR device 100 as collimated light beams 104, and

collect reflected light 106 from one or more objects in the environment of the LIDAR device 100 by the lens 150 for focusing towards the receive block 130 as focused light 108. The reflected light 106 comprises light from the collimated light beams 104 that was reflected by the one or more objects in the environment of the LIDAR device 100. The emitted light beams 102 and the focused light 108 traverse in the shared space 140 also included in the housing 110. In some examples, the emitted light beams 102 are propagating in a transmit path through the shared space 140 and the focused light 108 are propagating in a receive path through the shared space 140. In some examples, the transmit path at least partially overlaps the receive path in the shared space 140. The LIDAR device 100 can determine an aspect of the one or more objects (e.g., location, shape, etc.) in the environment of the LIDAR device 100 by processing the focused light 108 received by the receive block 130. For example, the LIDAR device 100 can compare a time when pulses included in the emitted light beams 102 were emitted by the transmit block 120 with a time when corresponding pulses included in the focused light 108 were received by the receive block 130 and determine the distance between the one or more objects and the LIDAR device 100 based on the comparison.

[0038] The housing 110 included in the LIDAR device 100 can provide a platform for mounting the various components included in the LIDAR device 100. The housing 110 can be formed from any material capable of supporting the various components of the LIDAR device 100 included in an interior space of the housing 110. For example, the housing 110 may be formed from a structural material such as plastic or metal.

[0039] In some examples, the housing 110 can be configured for optical shielding to reduce ambient light and/or unintentional transmission of the emitted light beams 102 from the transmit block 120 to the receive block 130. Optical shielding from ambient light of the

environment of the LIDAR device 100 can be achieved by forming and/or coating the outer surface of the housing 110 with a material that blocks the ambient light from the environment. Additionally, inner surfaces of the housing 110 can include and/or be coated with the material described above to optically isolate the transmit block 120 from the receive block 130 to prevent the receive block 130 from receiving the emitted light beams 102 before the emitted light beams 102 reach the lens 150.

[0040] In some examples, the housing 110 can be configured for electromagnetic shielding to reduce electromagnetic noise (e.g., Radio Frequency (RF) Noise, etc.) from ambient environment of the LIDAR device 110 and/or electromagnetic noise between the transmit block 120 and the receive block 130. Electromagnetic shielding can improve quality of the emitted light beams 102 emitted by the transmit block 120 and reduce noise in signals received and/or provided by the receive block 130. Electromagnetic shielding can be achieved by forming and/or coating the housing 110 with a material that absorbs electromagnetic radiation such as a metal, metallic ink, metallic foam, carbon foam, or any other material configured to absorb electromagnetic radiation. Metals that can be used for the electromagnetic shielding can include for example, copper or nickel.

[0041] In some examples, the housing 110 can be configured to have a substantially cylindrical shape and to rotate about an axis of the LIDAR device 100. For example, the housing 110 can have the substantially cylindrical shape with a diameter of approximately 10 centimeters. In some examples, the axis is substantially vertical. By rotating the housing 110 that includes the various components, in some examples, a three-dimensional map of a 360 degree view of the environment of the LIDAR device 100 can be determined without frequent recalibration of the arrangement of the various components of the LIDAR device 100.

Additionally or alternatively, the LIDAR device 100 can be configured to tilt the axis of rotation of the housing 110 to control the field of view of the LIDAR device 100.

[0042] Although not illustrated in Figure 1, the LIDAR device 100 can optionally include a mounting structure for the housing 110. The mounting structure can include a motor or other means for rotating the housing 110 about the axis of the LIDAR device 100. Alternatively, the mounting structure can be included in a device and/or system other than the LIDAR device 100.

[0043] In some examples, the various components of the LIDAR device 100 such as the transmit block 120, receive block 130, and the lens 150 can be removably mounted to the housing 110 in predetermined positions to reduce burden of calibrating the arrangement of each component and/or subcomponents included in each component. Thus, the housing 110 provides the platform for the various components of the LIDAR device 100 for ease of assembly, maintenance, calibration, and manufacture of the LIDAR device 100.

[0044] The transmit block 120 includes a plurality of light sources 122 that can be configured to emit the plurality of emitted light beams 102 via an exit aperture 124. In some examples, each of the plurality of emitted light beams 102 corresponds to one of the plurality of light sources 122. The transmit block 120 can optionally include a mirror 126 along the transmit path of the emitted light beams 102 between the light sources 122 and the exit aperture 124.

[0045] The light sources 122 can include laser diodes, light emitting diodes (LED), vertical cavity surface emitting lasers (VCSEL), organic light emitting diodes (OLED), polymer light emitting diodes (PLED), light emitting polymers (LEP), liquid crystal displays (LCD), microelectromechanical systems (MEMS), or any other device configured to selectively transmit, reflect, and/or emit light to provide the plurality of emitted light beams 102. In some examples,

the light sources 122 can be configured to emit the emitted light beams 102 in a wavelength range that can be detected by detectors 132 included in the receive block 130. The wavelength range could, for example, be in the ultraviolet, visible, and/or infrared portions of the electromagnetic spectrum. In some examples, the wavelength range can be a narrow wavelength range, such as provided by lasers. In one example, the wavelength range includes wavelengths that are approximately 905nm. Additionally, the light sources 122 can be configured to emit the emitted light beams 102 in the form of pulses. In some examples, the plurality of light sources 122 can be disposed on one or more substrates (e.g., printed circuit boards (PCB), flexible PCBs, etc.) and arranged to emit the plurality of light beams 102 towards the exit aperture 124.

[0046] In some examples, the plurality of light sources 122 can be configured to emit uncollimated light beams included in the emitted light beams 102. For example, the emitted light beams 102 can diverge in one or more directions along the transmit path due to the uncollimated light beams emitted by the plurality of light sources 122. In some examples, vertical and horizontal extents of the emitted light beams 102 at any position along the transmit path can be based on an extent of the divergence of the uncollimated light beams emitted by the plurality of light sources 122.

[0047] The exit aperture 124 arranged along the transmit path of the emitted light beams 102 can be configured to accommodate the vertical and horizontal extents of the plurality of light beams 102 emitted by the plurality of light sources 122 at the exit aperture 124. It is noted that the block diagram shown in Figure 1 is described in connection with functional modules for convenience in description. However, the functional modules in the block diagram of Figure 1 can be physically implemented in other locations. For example, although illustrated that the exit aperture 124 is included in the transmit block 120, the exit aperture 124 can be physically

included in both the transmit block 120 and the shared space 140. For example, the transmit block 120 and the shared space 140 can be separated by a wall that includes the exit aperture 124. In this case, the exit aperture 124 can correspond to a transparent portion of the wall. In one example, the transparent portion can be a hole or cut-away portion of the wall. In another example, the wall can be formed from a transparent substrate (e.g., glass) coated with a non-transparent material, and the exit aperture 124 can be a portion of the substrate that is not coated with the non-transparent material.

[0048] In some examples of the LIDAR device 100, it may be desirable to minimize size of the exit aperture 124 while accommodating the vertical and horizontal extents of the plurality of light beams 102. For example, minimizing the size of the exit aperture 124 can improve the optical shielding of the light sources 122 described above in the functions of the housing 110. Additionally or alternatively, the wall separating the transmit block 120 and the shared space 140 can be arranged along the receive path of the focused light 108, and thus, the exit aperture 124 can be minimized to allow a larger portion of the focused light 108 to reach the wall. For example, the wall can be coated with a reflective material (e.g., reflective surface 142 in shared space 140) and the receive path can include reflecting the focused light 108 by the reflective material towards the receive block 130. In this case, minimizing the size of the exit aperture 124 can allow a larger portion of the focused light 108 to reflect off the reflective material that the wall is coated with.

[0049] To minimize the size of the exit aperture 124, in some examples, the divergence of the emitted light beams 102 can be reduced by partially collimating the uncollimated light beams emitted by the light sources 122 to minimize the vertical and horizontal extents of the emitted light beams 102 and thus minimize the size of the exit aperture 124. For example, each

light source of the plurality of light sources 122 can include a cylindrical lens arranged adjacent to the light source. The light source may emit a corresponding uncollimated light beam that diverges more in a first direction than in a second direction. The cylindrical lens may pre-collimate the uncollimated light beam in the first direction to provide a partially collimated light beam, thereby reducing the divergence in the first direction. In some examples, the partially collimated light beam diverges less in the first direction than in the second direction. Similarly, uncollimated light beams from other light sources of the plurality of light sources 122 can have a reduced beam width in the first direction and thus the emitted light beams 102 can have a smaller divergence due to the partially collimated light beams. In this example, at least one of the vertical and horizontal extents of the exit aperture 124 can be reduced due to partially collimating the light beams 102.

[0050] Additionally or alternatively, to minimize the size of the exit aperture 124, in some examples, the light sources 122 can be arranged along a substantially curved surface defined by the transmit block 120. The curved surface can be configured such that the emitted light beams 102 converge towards the exit aperture 124, and thus the vertical and horizontal extents of the emitted light beams 102 at the exit aperture 124 can be reduced due to the arrangement of the light sources 122 along the curved surface of the transmit block 120. In some examples, the curved surface of the transmit block 120 can include a curvature along the first direction of divergence of the emitted light beams 102 and a curvature along the second direction of divergence of the emitted light beams 102, such that the plurality of light beams 102 converge towards a central area in front of the plurality of light sources 122 along the transmit path.

[0051] To facilitate such curved arrangement of the light sources 122, in some examples, the light sources 122 can be disposed on a flexible substrate (e.g., flexible PCB) having a

curvature along one or more directions. For example, the curved flexible substrate can be curved along the first direction of divergence of the emitted light beams 102 and the second direction of divergence of the emitted light beams 102. Additionally or alternatively, to facilitate such curved arrangement of the light sources 122, in some examples, the light sources 122 can be disposed on a curved edge of one or more vertically-oriented printed circuit boards (PCBs), such that the curved edge of the PCB substantially matches the curvature of the first direction (e.g., the vertical plane of the PCB). In this example, the one or more PCBs can be mounted in the transmit block 120 along a horizontal curvature that substantially matches the curvature of the second direction (e.g., the horizontal plane of the one or more PCBs). For example, the transmit block 120 can include four PCBs, with each PCB mounting sixteen light sources, so as to provide 64 light sources along the curved surface of the transmit block 120. In this example, the 64 light sources are arranged in a pattern such that the emitted light beams 102 converge towards the exit aperture 124 of the transmit block 120.

[0052] The transmit block 120 can optionally include the mirror 126 along the transmit path of the emitted light beams 102 between the light sources 122 and the exit aperture 124. By including the mirror 126 in the transmit block 120, the transmit path of the emitted light beams 102 can be folded to provide a smaller size of the transmit block 120 and the housing 110 of the LIDAR device 100 than a size of another transmit block where the transmit path that is not folded.

[0053] The receive block 130 includes a plurality of detectors 132 that can be configured to receive the focused light 108 via an entrance aperture 134. In some examples, each of the plurality of detectors 132 is configured and arranged to receive a portion of the focused light 108 corresponding to a light beam emitted by a corresponding light source of the plurality of light

sources 122 and reflected of the one or more objects in the environment of the LIDAR device 100. The receive block 130 can optionally include the detectors 132 in a sealed environment having an inert gas 136.

[0054] The detectors 132 may comprise photodiodes, avalanche photodiodes, phototransistors, cameras, active pixel sensors (APS), charge coupled devices (CCD), cryogenic detectors, or any other sensor of light configured to receive focused light 108 having wavelengths in the wavelength range of the emitted light beams 102.

[0055] To facilitate receiving, by each of the detectors 132, the portion of the focused light 108 from the corresponding light source of the plurality of light sources 122, the detectors 132 can be disposed on one or more substrates and arranged accordingly. For example, the light sources 122 can be arranged along a curved surface of the transmit block 120, and the detectors 132 can also be arranged along a curved surface of the receive block 130. The curved surface of the receive block 130 can similarly be curved along one or more axes of the curved surface of the receive block 130. Thus, each of the detectors 132 are configured to receive light that was originally emitted by a corresponding light source of the plurality of light sources 122.

[0056] To provide the curved surface of the receive block 130, the detectors 132 can be disposed on the one or more substrates similarly to the light sources 122 disposed in the transmit block 120. For example, the detectors 132 can be disposed on a flexible substrate (e.g., flexible PCB) and arranged along the curved surface of the flexible substrate to each receive focused light originating from a corresponding light source of the light sources 122. In this example, the flexible substrate may be held between two clamping pieces that have surfaces corresponding to the shape of the curved surface of the receive block 130. Thus, in this example, assembly of the

receive block 130 can be simplified by sliding the flexible substrate onto the receive block 130 and using the two clamping pieces to hold it at the correct curvature.

[0057] The focused light 108 traversing along the receive path can be received by the detectors 132 via the entrance aperture 134. In some examples, the entrance aperture 134 can include a filtering window that passes light having wavelengths within the wavelength range emitted by the plurality of light sources 122 and attenuates light having other wavelengths. In this example, the detectors 132 receive the focused light 108 substantially comprising light having the wavelengths within the wavelength range.

[0058] In some examples, the plurality of detectors 132 included in the receive block 130 can include, for example, avalanche photodiodes in a sealed environment that is filled with the inert gas 136. The inert gas 136 may comprise, for example, nitrogen.

[0059] The shared space 140 includes the transmit path for the emitted light beams 102 from the transmit block 120 to the lens 150, and includes the receive path for the focused light 108 from the lens 150 to the receive block 130. In some examples, the transmit path at least partially overlaps with the receive path in the shared space 140. By including the transmit path and the receive path in the shared space 140, advantages with respect to size, cost, and/or complexity of assembly, manufacture, and/or maintenance of the LIDAR device 100 can be provided.

[0060] In some examples, the shared space 140 can include a reflective surface 142. The reflective surface 142 can be arranged along the receive path and configured to reflect the focused light 108 towards the entrance aperture 134 and onto the detectors 132. The reflective surface 142 may comprise a prism, mirror or any other optical element configured to reflect the

focused light 108 towards the entrance aperture 134 in the receive block 130. In some examples where a wall separates the shared space 140 from the transmit block 120. In these examples, the wall may comprise a transparent substrate (e.g., glass) and the reflective surface 142 may comprise a reflective coating on the wall with an uncoated portion for the exit aperture 124.

[0061] In embodiments including the reflective surface 142, the reflective surface 142 can reduce size of the shared space 140 by folding the receive path similarly to the mirror 126 in the transmit block 120. Additionally or alternatively, in some examples, the reflective surface 142 can direct the focused light 103 to the receive block 130 further providing flexibility to the placement of the receive block 130 in the housing 110. For example, varying the tilt of the reflective surface 142 can cause the focused light 108 to be reflected to various portions of the interior space of the housing 110, and thus the receive block 130 can be placed in a corresponding position in the housing 110. Additionally or alternatively, in this example, the LIDAR device 100 can be calibrated by varying the tilt of the reflective surface 142.

[0062] The lens 150 mounted to the housing 110 can have an optical power to both collimate the emitted light beams 102 from the light sources 122 in the transmit block 120, and focus the reflected light 106 from the one or more objects in the environment of the LIDAR device 100 onto the detectors 132 in the receive block 130. In one example, the lens 150 has a focal length of approximately 120 mm. By using the same lens 150 to perform both of these functions, instead of a transmit lens for collimating and a receive lens for focusing, advantages with respect to size, cost, and/or complexity can be provided. In some examples, collimating the emitted light beams 102 to provide the collimated light beams 104 allows determining the distance travelled by the collimated light beams 104 to the one or more objects in the environment of the LIDAR device 100.

[0063] In an example scenario, the emitted light beams 102 from the light sources 122 traversing along the transmit path can be collimated by the lens 150 to provide the collimated light beams 104 to the environment of the LIDAR device 100. The collimated light beams 104 may then reflect off the one or more objects in the environment of the LIDAR device 100 and return to the lens 150 as the reflected light 106. The lens 150 may then collect and focus the reflected light 106 as the focused light 108 onto the detectors 132 included in the receive block 130. In some examples, aspects of the one or more objects in the environment of the LIDAR device 100 can be determined by comparing the emitted light beams 102 with the focused light beams 108. The aspects can include, for example, distance, shape, color, and/or material of the one or more objects. Additionally, in some examples, rotating the housing 110, a three dimensional map of the surroundings of the LIDAR device 100 can be determined.

[0064] In some examples where the plurality of light sources 122 are arranged along the curved surface of the transmit block 120, the lens 150 can be configured to have a focal surface corresponding to the curved surface of the transmit block 120. For example, the lens 150 can include an aspheric surface outside the housing 110 and a toroidal surface inside the housing 110 facing the shared space 140. In this example, the shape of the lens 150 allows the lens 150 to both collimate the emitted light beams 102 and focus the reflected light 106. Additionally, in this example, the shape of the lens 150 allows the lens 150 to have the focal surface corresponding to the curved surface of the transmit block 120. In some examples, the focal surface provided by the lens 150 substantially matches the curved shape of the transmit block 120. Additionally, in some examples, the detectors 132 can be arranged similarly in the curved shape of the receive block 130 to receive the focused light 108 along the curved focal surface provided by the lens 150. Thus, in some examples, the curved surface of the receive block 130 may also substantially

match the curved focal surface provided by the lens 150.

[0065] Figure 2 is a cross-section view of an example LIDAR device 200. In this example, the LIDAR device 200 includes a housing 210 that houses a transmit block 220, a receive block 230, a shared space 240, and a lens 250. For purposes of illustration, Figure 2 shows an x-y-z axis, in which the z-axis is in a substantially vertical direction and the x-axis and y-axis define a substantially horizontal plane.

[0066] The structure, function, and operation of various components included in the LIDAR device 200 are similar to corresponding components included in the LIDAR device 100 described in Figure 1. For example, the housing 210, the transmit block 220, the receive block 230, the shared space 240, and the lens 250 are similar, respectively, to the housing 110, the transmit block 120, the receive block 130, and the shared space 140 described in Figure 1.

[0067] The transmit block 220 includes a plurality of light sources 222a-c arranged along a curved focal surface 228 defined by the lens 250. The plurality of light sources 222a-c can be configured to emit, respectively, the plurality of light beams 202a-c having wavelengths within a wavelength range. For example, the plurality of light sources 222a-c may comprise laser diodes that emit the plurality of light beams 202a-c having the wavelengths within the wavelength range. The plurality of light beams 202a-c are reflected by mirror 224 through an exit aperture 226 into the shared space 240 and towards the lens 250. The structure, function, and operation of the plurality of light sources 222a-c, the mirror 224, and the exit aperture 226 can be similar, respectively, to the plurality of light sources 122, the mirror 124, and the exit aperture 226 discussed in the description of the LIDAR device 100 of Figure 1.

[0068] Although Figure 2 shows that the curved focal surface 228 is curved in the x-y

plane (horizontal plane), additionally or alternatively, the plurality of light sources 222a-c may be arranged along a focal surface that is curved in a vertical plane. For example, the curved focal surface 228 can have a curvature in a vertical plane, and the plurality of light sources 222a-c can include additional light sources arranged vertically along the curved focal surface 228 and configured to emit light beams directed at the mirror 224 and reflected through the exit aperture 226.

[0069] Due to the arrangement of the plurality of light sources 222a-c along the curved focal surface 228, the plurality of light beams 202a-c, in some examples, may converge towards the exit aperture 226. Thus, in these examples, the exit aperture 226 may be minimally sized while being capable of accommodating vertical and horizontal extents of the plurality of light beams 202a-c. Additionally, in some examples, the curved focal surface 228 can be defined by the lens 250. For example, the curved focal surface 228 may correspond to a focal surface of the lens 250 due to shape and composition of the lens 250. In this example, the plurality of light sources 222a-c can be arranged along the focal surface defined by the lens 250 at the transmit block.

[0070] The plurality of light beams 202a-c propagate in a transmit path that extends through the transmit block 220, the exit aperture 226, and the shared space 240 towards the lens 250. The lens 250 collimates the plurality of light beams 202a-c to provide collimated light beams 204a-c into an environment of the LIDAR device 200. The collimated light beams 204a-c correspond, respectively, to the plurality of light beams 202a-c. In some examples, the collimated light beams 204a-c reflect off one or more objects in the environment of the LIDAR device 200 as reflected light 206. The reflected light 206 may be focused by the lens 250 into the shared space 240 as focused light 208 traveling along a receive path that extends through the

shared space 240 onto the receive block 230. For example, the focused light 208 may be reflected by the reflective surface 242 as focused light 208a-c propagating towards the receive block 230.

[0071] The lens 250 may be capable of both collimating the plurality of light beams 202a-c and focusing the reflected light 206 along the receive path 208 towards the receive block 230 due to shape and composition of the lens 250. For example, the lens 250 can have an aspheric surface 252 facing outside of the housing 210 and a toroidal surface 254 facing the shared space 240. By using the same lens 250 to perform both of these functions, instead of a transmit lens for collimating and a receive lens for focusing, advantages with respect to size, cost, and/or complexity can be provided.

[0072] The exit aperture 226 is included in a wall 244 that separates the transmit block 220 from the shared space 240. In some examples, the wall 244 can be formed from a transparent material (e.g., glass) that is coated with a reflective material 242. In this example, the exit aperture 226 may correspond to the portion of the wall 244 that is not coated by the reflective material 242. Additionally or alternatively, the exit aperture 226 may comprise a hole or cut-away in the wall 244.

[0073] The focused light 208 is reflected by the reflective surface 242 and directed towards an entrance aperture 234 of the receive block 230. In some examples, the entrance aperture 234 may comprise a filtering window configured to allow wavelengths in the wavelength range of the plurality of light beams 202a-c emitted by the plurality of light sources 222a-c and attenuate other wavelengths. The focused light 208a-c reflected by the reflective surface 242 from the focused light 208 propagates, respectively, onto a plurality of detectors

232a-c. The structure, function, and operation of the entrance aperture 234 and the plurality of detectors 232a-c is similar, respectively, to the entrance aperture 134 and the plurality of detectors 132 included in the LIDAR device 100 described in Figure 1.

[0074] The plurality of detectors 232a-c can be arranged along a curved focal surface 238 of the receive block 230. Although Figure 2 shows that the curved focal surface 238 is curved along the x-y plane (horizontal plane), additionally or alternatively, the curved focal surface 238 can be curved in a vertical plane. The curvature of the focal surface 238 is also defined by the lens 250. For example, the curved focal surface 238 may correspond to a focal surface of the light projected by the lens 250 along the receive path at the receive block 230.

[0075] Each of the focused light 208a-c corresponds, respectively, to the emitted light beams 202a-c and is directed onto, respectively, the plurality of detectors 232a-c. For example, the detector 232a is configured and arranged to received focused light 208a that corresponds to collimated light beam 204a reflected of the one or more objects in the environment of the LIDAR device 200. In this example, the collimated light beam 204a corresponds to the light beam 202a emitted by the light source 222a. Thus, the detector 232a receives light that was emitted by the light source 222a, the detector 232b receives light that was emitted by the light source 222b, and the detector 232c receives light that was emitted by the light source 222c.

[0076] By comparing the received light 208a-c with the emitted light beams 202a-c, at least one aspect of the one or more object in the environment of the LIDAR device 200 may be determined. For example, by comparing a time when the plurality of light beams 202a-c were emitted by the plurality of light sources 222a-c and a time when the plurality of detectors 232a-c received the focused light 208a-c, a distance between the LIDAR device 200 and the one or more

object in the environment of the LIDAR device 200 may be determined. In some examples, other aspects such as shape, color, material, etc. may also be determined.

[0077] In some examples, the LIDAR device 200 may be rotated about an axis to determine a three-dimensional map of the surroundings of the LIDAR device 200. For example, the LIDAR device 200 may be rotated about a substantially vertical axis as illustrated by arrow 290. Although illustrated that the LIDAR device 200 is rotated counter clock-wise about the axis as illustrated by the arrow 290, additionally or alternatively, the LIDAR device 200 may be rotated in the clockwise direction. In some examples, the LIDAR device 200 may be rotated 360 degrees about the axis. In other examples, the LIDAR device 200 may be rotated back and forth along a portion of the 360 degree view of the LIDAR device 200. For example, the LIDAR device 200 may be mounted on a platform that wobbles back and forth about the axis without making a complete rotation.

[0078] Figure 3A is a perspective view of an example LIDAR device 300 fitted with various components, in accordance with at least some embodiments described herein. Figure 3B is a perspective view of the example LIDAR device 300 shown in Figure 3A with the various components removed to illustrate interior space of the housing 310. The structure, function, and operation of the LIDAR device 300 is similar to the LIDAR devices 100 and 200 described, respectively, in Figures 1 and 2. For example, the LIDAR device 300 includes a housing 310 that houses a transmit block 320, a receive block 330, and a lens 350 that are similar, respectively, to the housing 110, the transmit block 120, the receive block 130, and the lens 150 described in Figure 1. Additionally, collimated light beams 304 propagate from the lens 350 toward an environment of the LIDAR device 300 and reflect of one or more objects in the environment as reflected light 306, similarly to the collimated light beams 104 and reflected light

106 described in Figure 1.

[0079] The LIDAR device 300 can be mounted on a mounting structure 360 and rotated about an axis to provide a 360 degree view of the environment surrounding the LIDAR device 300. In some examples, the mounting structure 360 may comprise a movable platform that may tilt in one or more directions to change the axis of rotation of the LIDAR device 300.

[0080] As illustrated in Figure 3B, the various components of the LIDAR device 300 can be removably mounted to the housing 310. For example, the transmit block 320 may comprise one or more printed circuit boards (PCBs) that are fitted in the portion of the housing 310 where the transmit block 320 can be mounted. Additionally, the receive block 330 may comprise a plurality of detectors 332 mounted to a flexible substrate and can be removably mounted to the housing 310 as a block that includes the plurality of detectors. Similarly, the lens 350 can be mounted to another side of the housing 310.

[0081] A plurality of light beams 302 can be transmitted by the transmit block 320 into the shared space 340 and towards the lens 350 to be collimated into the collimated light beams 304. Similarly, the received light 306 can be focused by the lens 350 and directed through the shared space 340 onto the receive block 330.

[0082] Figure 4 illustrates an example transmit block 420, in accordance with at least some embodiments described herein. Transmit block 420 can correspond to the transmit blocks 120, 220, and 320 described in Figures 1-3. For example, the transmit block 420 includes a plurality of light sources 422a-c similar to the plurality of light sources 222a-c included in the transmit block 220 of Figure 2. Additionally, the light sources 422a-c are arranged along a focal surface 428, which is curved in a vertical plane. The light sources 422a-c are configured to emit

a plurality of light beams 402a-c that converge and propagate through an exit aperture 426 in a wall 444.

[0083] Although the plurality of light sources 422a-c can be arranged along a focal surface 428 that is curved in a vertical plane, additionally or alternatively, the plurality of light sources 422a-c can be arranged along a focal surface that is curved in a horizontal plane or a focal surface that is curved both vertically and horizontally. For example, the plurality of light sources 422a-c can be arranged in a curved three dimensional grid pattern. For example, the transmit block 420 may comprise a plurality of printed circuit board (PCB) vertically mounted such that a column of light sources such as the plurality of light sources 422a-c are along the vertical axis of each PCB and each of the plurality of PCBs can be arranged adjacent to other vertically mounted PCBs along a horizontally curved plane to provide the three dimensional grid pattern.

[0084] As shown in Figure 4, the light beams 402a-c converge towards the exit aperture 426 which allows the size of the exit aperture 426 to be minimized while accommodating vertical and horizontal extents of the light beams 402a-c similarly to the exit aperture 226 described in Figure 2.

[0085] As noted above in the description of Figure 1, the light from light sources 122 could be partially collimated to fit through the exit aperture 124. Figures 5A, 5B, and 5C illustrate an example of how such partial collimation could be achieved. In this example, a light source 500 is made up of a laser diode 502 and a cylindrical lens 504. As shown in Figure 5A, laser diode 502 has an aperture 506 with a shorter dimension corresponding to a fast axis 508 and a longer dimension corresponding to a slow axis 510. Figures 5B and 5C show an

uncollimated laser beam 512 being emitted from laser diode 502. Laser beam 512 diverges in two directions, one direction defined by fast axis 508 and another, generally orthogonal direction defined by slow axis 510. Figure 5B shows the divergence of laser beam 512 along fast axis 508, whereas Figure 5C shows the divergence of laser beam 512 along slow axis 510. Laser beam 512 diverges more quickly along fast axis 508 than along slow axis 510.

[0086] In one specific example, laser diode 502 is an Osram SPL DL90_3 nanostack pulsed laser diode that emits pulses of light with a range of wavelengths from about 896 nm to about 910 nm (a nominal wavelength of 905 nm). In this specific example, the aperture has a shorter dimension of about 10 microns, corresponding to its fast axis, and a longer dimension of about 200 microns, corresponding to its slow axis. The divergence of the laser beam in this specific example is about 25 degrees along the fast axis and about 11 degrees along the slow axis. It is to be understood that this specific example is illustrative only. Laser diode 502 could have a different configuration, different aperture sizes, different beam divergences, and/or emit different wavelengths.

[0087] As shown in Figures 5B and 5C, cylindrical lens 504 may be positioned in front of aperture 506 with its cylinder axis 514 generally parallel to slow axis 510 and perpendicular to fast axis 508. In this arrangement, cylindrical lens 504 can pre-collimate laser beam 512 along fast axis 508, resulting in partially collimated laser beam 516. In some examples, this pre-collimation may reduce the divergence along fast axis 508 to about one degree or less. Nonetheless, laser beam 516 is only partially collimated because the divergence along slow axis 510 may be largely unchanged by cylindrical lens 504. Thus, whereas uncollimated laser beam 512 emitted by laser diode has a higher divergence along fast axis 508 than along slow axis 510, partially collimated laser beam 516 provided by cylindrical lens 504 may have a higher

divergence along slow axis 510 than along fast axis 508. Further, the divergences along slow axis 510 in uncollimated laser beam 512 and in partially collimated laser beam 516 may be substantially equal.

[0088] In one example, cylindrical lens 504 is a microrod lens with a diameter of about 600 microns that is placed about 250 microns in front of aperture 506. The material of the microrod lens could be, for example, fused silica or a borosilicate crown glass, such as Schott BK7. Alternatively, the microrod lens could be a molded plastic cylinder or acylinder. Cylindrical lens 504 could also be used to provide magnification along fast axis 508. For example, if the dimensions of aperture 506 are 10 microns by 200 microns, as previously described, and cylindrical lens 504 is a microrod lens as described above, then cylindrical lens 504 may magnify the shorter dimension (corresponding to fast axis 508) by about 20 times. This magnification effectively stretches out the shorter dimension of aperture 506 to about the same as the longer dimension. As a result, when light from laser beam 516 is focused, for example, focused onto a detector, the focused spot could have a substantially square shape instead of the rectangular slit shape of aperture 506.

[0089] Figure 6A illustrates an example receive block 630, in accordance with at least some embodiments described herein. Figure 6B illustrates a side view of three detectors 632a-c included in the receive block 630 of Figure 6A. Receive block 630 can correspond to the receive blocks 130, 230, and 330 described in Figures 1-3. For example, the receive block 630 includes a plurality of detectors 632a-c arranged along a curved surface 638 defined by a lens 650 similarly to the receive block 230, the detectors 232 and the curved plane 238 described in Figure 2. Focused light 608a-c from lens 650 propagates along a receive path that includes a reflective surface 642 onto the detectors 632a-c similar, respectively, to the focused light 208a-c,

the lens 250, the reflective surface 242, and the detectors 232a-c described in Figure 2.

[0090] The receive block 630 comprises a flexible substrate 680 on which the plurality of detectors 632a-c are arranged along the curved surface 638. The flexible substrate 680 conforms to the curved surface 638 by being mounted to a receive block housing 690 having the curved surface 638. As illustrated in Figure 6, the curved surface 638 includes the arrangement of the detectors 632a-c curved along a vertical and horizontal axis of the receive block 630.

[0091] Figures 7A and 7B illustrate an example lens 750 with an aspheric surface 752 and a toroidal surface 754, in accordance with at least some embodiments described herein. Figure 7B illustrates a cross-section view of the example lens 750 shown in Figure 7A. The lens 750 can correspond to lens 150, 250, and 350 included in Figures 1-3. For example, the lens 750 can be configured to both collimate light incident on the toroidal surface 754 from a light source into collimated light propagating out of the aspheric surface 752, and focus reflected light entering from the aspheric surface 752 onto a detector. The structure of the lens 750 including the aspheric surface 752 and the toroidal surface 754 allows the lens 750 to perform both functions of collimating and focusing described in the example above.

[0092] In some examples, the lens 750 defines a focal surface of the light propagating through the lens 750 due to the aspheric surface 752 and the toroidal surface 754. In these examples, the light sources providing the light entering the toroidal surface 754 can be arranged along the defined focal surface, and the detectors receiving the light focused from the light entering the aspheric surface 752 can also be arranged along the defined focal surface.

[0093] By using the lens 750 that performs both of these functions (collimating transmitted light and focusing received light), instead of a transmit lens for collimating and a

receive lens for focusing, advantages with respect to size, cost, and/or complexity can be provided.

[0094] Figure 8A illustrates an example LIDAR device 810 mounted on a vehicle 800, in accordance with at least some embodiments described herein. Figure 8A shows a Right Side View, Front View, Back View, and Top View of the vehicle 800. Although vehicle 800 is illustrated in Figure 8 as a car, other examples are possible. For instance, the vehicle 800 could represent a truck, a van, a semi-trailer truck, a motorcycle, a golf cart, an off-road vehicle, or a farm vehicle, among other examples.

[0095] The structure, function, and operation of the LIDAR device 810 shown in Figure 8A is similar to the example LIDAR devices 100, 200, and 300 shown in Figures 1-3. For example, the LIDAR device 810 can be configured to rotate about an axis and determine a three-dimensional map of a surrounding environment of the LIDAR device 810. To facilitate the rotation, the LIDAR device 810 can be mounted on a platform 802. In some examples, the platform 802 may comprise a movable mount that allows the vehicle 800 to control the axis of rotation of the LIDAR device 810.

[0096] While the LIDAR device 810 is shown to be mounted in a particular location on the vehicle 800, in some examples, the LIDAR device 810 may be mounted elsewhere on the vehicle 800. For example, the LIDAR device 810 may be mounted anywhere on top of the vehicle 800, on a side of the vehicle 800, under the vehicle 800, on a hood of the vehicle 800, and/or on a trunk of the vehicle 800.

[0097] The LIDAR device 810 includes a lens 812 through which collimated light is transmitted from the LIDAR device 810 to the surrounding environment of the LIDAR device

810, similarly to the lens 150, 250, and 350 described in Figures 1-3. Similarly, the lens 812 can also be configured to receive reflected light from the surrounding environment of the LIDAR device 810 that were reflected off one or more objects in the surrounding environment.

[0098] Figure 8B illustrates a scenario where the LIDAR device 810 shown in Figure 8A and scanning an environment 830 that includes one or more objects, in accordance with at least some embodiments described herein. In this example scenario, vehicle 800 can be traveling on a road 822 in the environment 830. By rotating the LIDAR device 810 about the axis defined by the platform 802, the LIDAR device 810 may be able to determine aspects of objects in the surrounding environment 830, such as lane lines 824a-b, other vehicles 826a-c, and/or street sign 828. Thus, the LIDAR device 810 can provide the vehicle 800 with information about the objects in the surrounding environment 830, including distance, shape, color, and/or material type of the objects.

[0099] Figure 9 is a flowchart of a method 900 of operating a LIDAR device, in accordance with at least some embodiments described herein. Method 900 shown in Figure 9 presents an embodiment of a method that could be used with the LIDAR devices 100, 200, and 300, for example. Method 900 may include one or more operations, functions, or actions as illustrated by one or more of blocks 902-912. Although the blocks are illustrated in a sequential order, these blocks may in some instances be performed in parallel, and/or in a different order than those described herein. Also, the various blocks may be combined into fewer blocks, divided into additional blocks, and/or removed based upon the desired implementation.

[00100] In addition, for the method 900 and other processes and methods disclosed herein, the flowchart shows functionality and operation of one possible implementation of present

embodiments. In this regard, each block may represent a module, a segment, or a portion of a manufacturing or operation process.

[00101] At block 902, the method 900 includes rotating a housing of a light detection and ranging (LIDAR) device about an axis, wherein the housing has an interior space that includes a transmit block, a receive block, and a shared space, wherein the transmit block has an exit aperture, and wherein the receive block has an entrance aperture.

[00102] At block 904, the method 900 includes emitting, by a plurality of light sources in the transmit block, a plurality of light beams that enter the shared space via a transmit path, the light beams comprising light having wavelengths in a wavelength range.

[00103] At block 906, the method 900 includes receiving the light beams at a lens mounted to the housing along the transmit path.

[00104] At block 908, the method 900 includes collimating, by the lens, the light beams for transmission into an environment of the LIDAR device.

[00105] At block 910, the method 900 includes focusing, by the lens, the collected light onto a plurality of detectors in the receive block via a receive path that extends through the shared space and the entrance aperture of the receive block.

[00106] At block 912, the method 900 includes detecting, by the plurality of detectors in the receive block, light from the focused light having wavelengths in the wavelength range.

[00107] For example, a LIDAR device such as the LIDAR device 200 can be rotated about an axis (block 902). A transmit block, such as the transmit block 220, can include a plurality of light sources that emit light beams having wavelengths in a wavelength range,

through an exit aperture and a shared space to a lens (block 904). The light beams can be received by the lens (block 906) and collimated for transmission to an environment of the LIDAR device (block 908). The collimated light may then reflect off one or more objects in the environment of the LIDAR device and return as reflected light collected by the lens. The lens may then focus the collected light onto a plurality of detectors in the receive block via a receive path that extends through the shared space and an entrance aperture of the receive block (block 910). The plurality of detectors in the receive block may then detect light from the focused light having wavelengths in the wavelength range of the emitted light beams from the light sources (block 912).

[00108] Within examples, devices and operation methods described include a LIDAR device rotated about an axis and configured to transmit collimated light and focus reflected light. The collimation and focusing can be performed by a shared lens. By using a shared lens that performs both of these functions, instead of a transmit lens for collimating and a receive lens for focusing, advantages with respect to size, cost, and/or complexity can be provided. Additionally, in some examples, the shared lens can define a curved focal surface. In these examples, the light sources emitting light through the shared lens and the detectors receiving light focused by the shared lens can be arranged along the curved focal surface defined by the shared lens.

[00109] It should be understood that arrangements described herein are for purposes of example only. As such, those skilled in the art will appreciate that other arrangements and other elements (e.g. machines, interfaces, functions, orders, and groupings of functions, etc.) can be used instead, and some elements may be omitted altogether according to the desired results. Further, many of the elements that are described are functional entities that may be implemented as discrete or distributed components or in conjunction with other components, in any suitable

combination and location, or other structural elements described as independent structures may be combined.

[00110] While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope being indicated by the following claims, along with the full scope of equivalents to which such claims are entitled. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting.

CLAIMS

What is claimed is:

1. A light detection and ranging (LIDAR) device, comprising:

a housing configured to rotate about an axis, wherein the housing has an interior space that includes a transmit block, a receive block, and a shared space, wherein the transmit block has an exit aperture, and wherein the receive block has an entrance aperture;

a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams that enter the shared space through the exit aperture and traverse the shared space via a transmit path, the light beams comprising light having wavelengths in a wavelength range;

a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and

a lens mounted to the housing, wherein the lens is configured to receive the light beams via the transmit path, collimate the light beams for transmission into an environment of the LIDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device, and focus the collected light onto the detectors via a receive path that extends through the shared space and the entrance aperture of the receive block.

2. The LIDAR device of claim 1, wherein each detector in the plurality of detectors is associated with a corresponding light source in the plurality of light sources, and wherein the

lens is configured to focus onto each detector a respective portion of the collected light that comprises light from the detector's corresponding light source.

3. The LIDAR device of claim 1, wherein the exit aperture is in a wall that separates the transmit block from the shared space.

4. The LIDAR device of claim 3, further comprising a reflective surface proximate to the exit aperture, wherein the receive path includes reflection by the reflective surface.

5. The LIDAR device of claim 4, wherein the wall comprises a transparent material, the reflective surface covers a portion of the transparent material, and the exit aperture corresponds to a portion of the transparent material that is not covered by the reflective surface.

6. The LIDAR device of claim 1, wherein the transmit path at least partially overlaps the receive path in the shared space.

7. The LIDAR device of claim 1, wherein the lens defines a curved focal surface in the transmit block and a curved focal surface in the receive block.

8. The LIDAR device of claim 7, wherein the light sources in the plurality of light sources are arranged in a pattern substantially corresponding to the curved focal surface in the transmit block, and wherein the detectors in the plurality of detectors are arranged in a pattern substantially corresponding to the curved focal surface in the receive block.

9. The LIDAR device of claim 1, wherein the lens has an aspheric surface and a toroidal surface.

10. The LIDAR device of claim 9, wherein the toroidal surface is in the shared space within the housing and the aspheric surface is outside of the housing.

11. The LIDAR device of claim 1, wherein the axis is substantially vertical.

12. The LIDAR device of claim 1, further comprising a mirror in the transmit block, wherein the mirror is configured to reflect the light beams toward the exit aperture.

13. The LIDAR device of claim 1, wherein the receive block comprises a sealed environment containing an inert gas.

14. The LIDAR device of claim 1, wherein the entrance aperture comprises a material that passes light having wavelengths in the wavelength range and attenuates light having other wavelengths.

15. The LIDAR device of claim 1, wherein each light source in the plurality of light sources comprises a respective laser diode.

16. The LIDAR device of claim 1, wherein each detector in the plurality of detectors comprises a respective avalanche photodiode.

17. A method comprising:

rotating a housing of a light detection and ranging (LIDAR) device about an axis, wherein the housing has an interior space that includes a transmit block, a receive block, and a shared space, wherein the transmit block has an exit aperture, and wherein the receive block has an entrance aperture;

emitting, by a plurality of light sources in the transmit block, a plurality of light beams that enter the shared space via a transmit path, the light beams comprising light having wavelengths in a wavelength range;

receiving the light beams at a lens mounted to the housing along the transmit path;

collimating, by the lens, the light beams for transmission into an environment of the LIDAR device;

collecting, by the lens, light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device;

focusing, by the lens, the collected light onto a plurality of detectors in the receive block via a receive path that extends through the shared space and the entrance aperture of the receive block; and

detecting, by the plurality of detectors in the receive block, light from the focused light having wavelengths in the wavelength range.

18. The method of claim 17, wherein each detector in the plurality of detectors is associated with a corresponding light source in the plurality of light sources, the method further comprising:

focusing onto each detector, by the lens, a respective portion of the collected light that comprises light from the detector's corresponding light source.

19. The method of claim 17, the method further comprising:

reflecting, by a reflective surface in the shared space, the focused light along the receive path toward the entrance aperture of the receive block, wherein the reflective surface is proximate to the exit aperture, and wherein the receive path includes the reflecting by the reflective surface.

20. The method of claim 17, further comprising:

reflecting, by a mirror in the transmit block, the emitted light beams toward the exit aperture.

ABSTRACT

A LIDAR device may transmit light pulses originating from one or more light sources and may receive reflected light pulses that are then detected by one or more detectors. The LIDAR device may include a lens that both (i) collimates the light from the one or more light sources to provide collimated light for transmission into an environment of the LIDAR device and (ii) focuses the reflected light onto the one or more detectors. The lens may define a curved focal surface in a transmit path of the light from the one or more light sources and a curved focal surface in a receive path of the one or more detectors. The one or more light sources may be arranged along the curved focal surface in the transmit path. The one or more detectors may be arranged along the curved focal surface in the receive path.

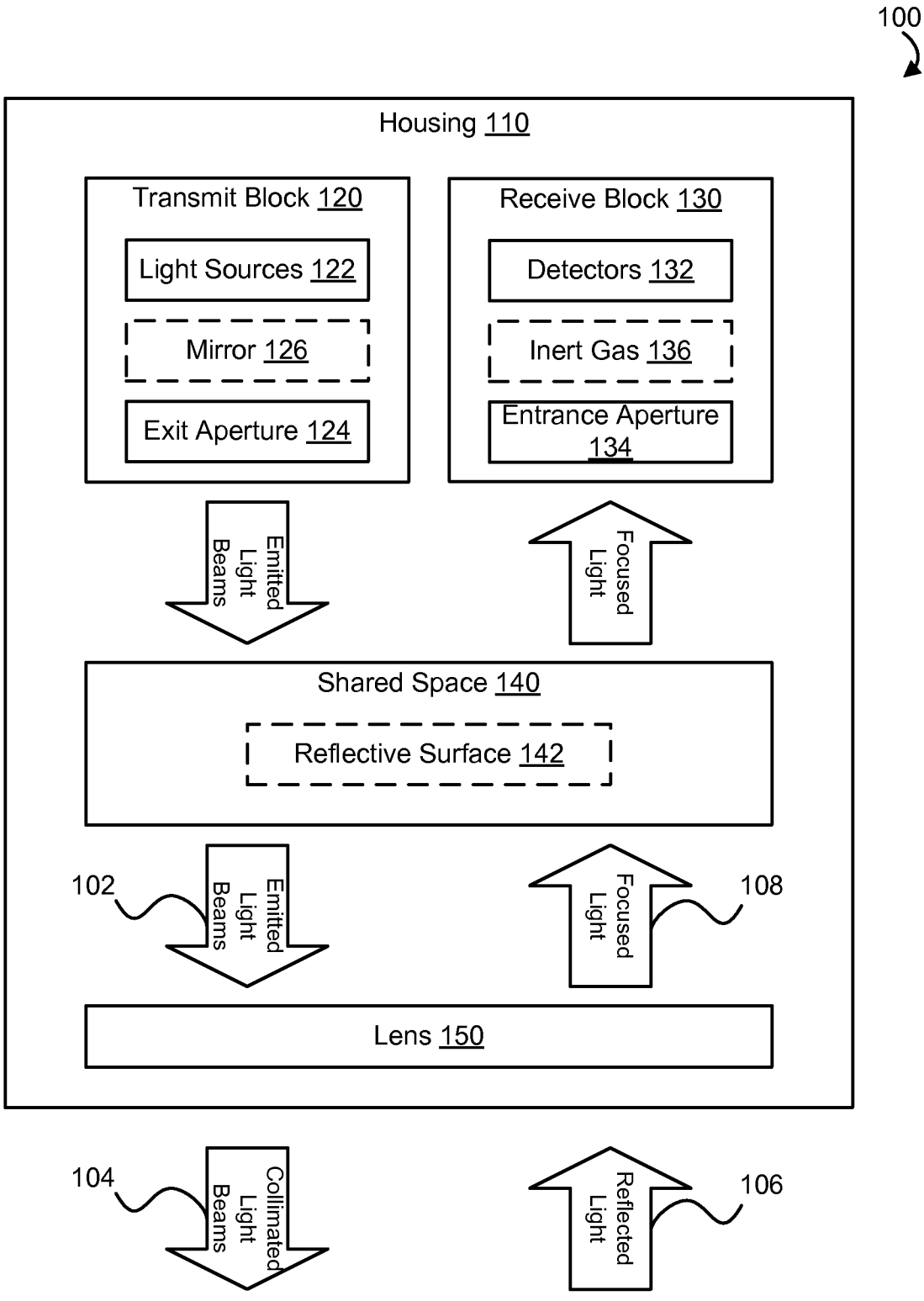
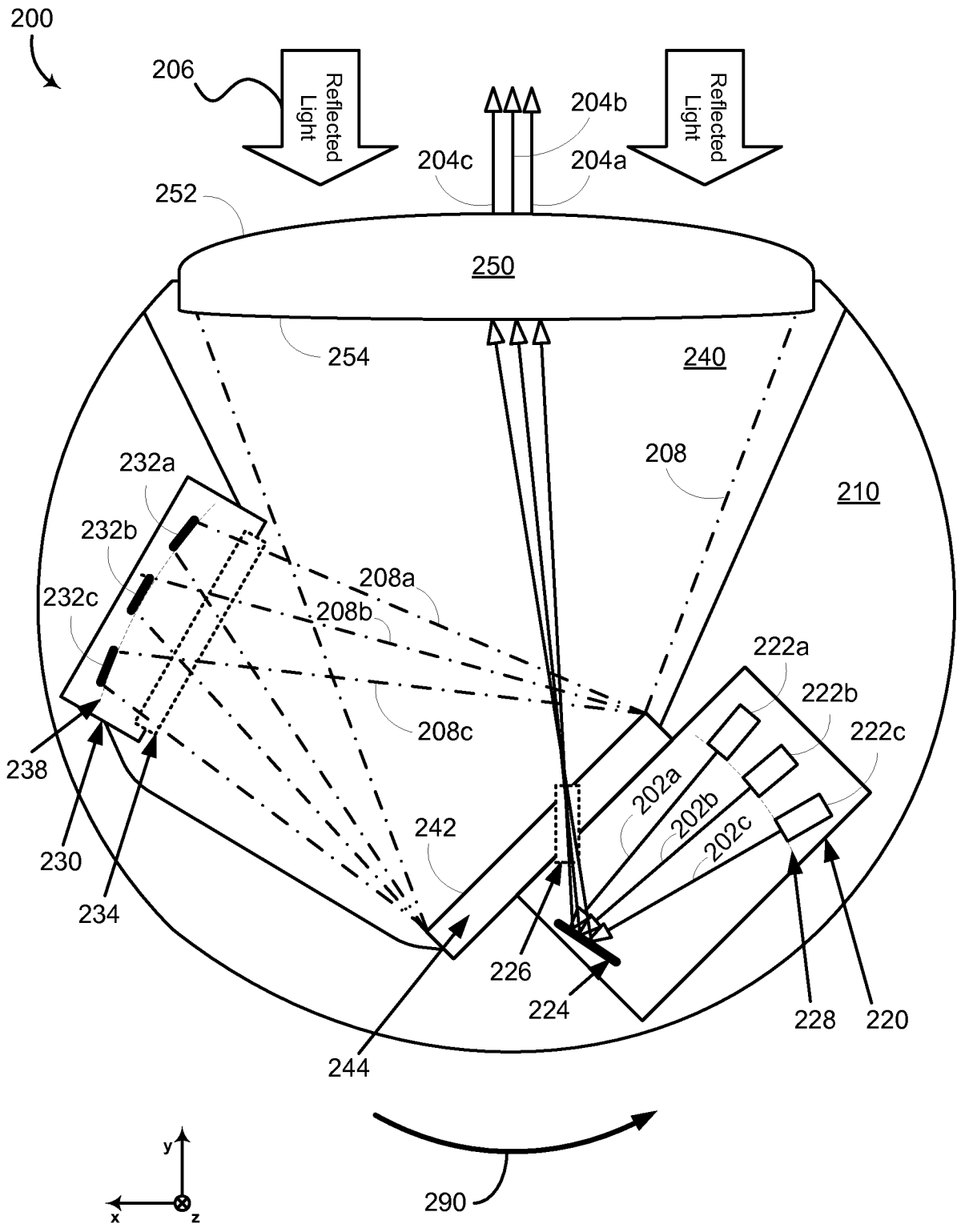

100
Housing 110
Transmit Block 120
Light Sources 122
Mirror 126
Exit Aperture 124
Receive Block 130
Detectors 132
Inert Gas 136
Entrance Aperture 134
Emitted Light Beams
Focused Light
Shared Space 140
Reflective Surface 142
102
Emitted Light Beams
Focused Light
108
Lens 150
104
Collimated Light Beams
Reflected Light
106

FIG. 1


200
206
Reflected Light
Reflected Light
204b
204c
204a
252
250
254
240
208
210
232a
232b
232c
208a
208b
208c
222a
222b
222c
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242
202a
202b
202c
226
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228
220
244
290
y
x
z

FIG. 2

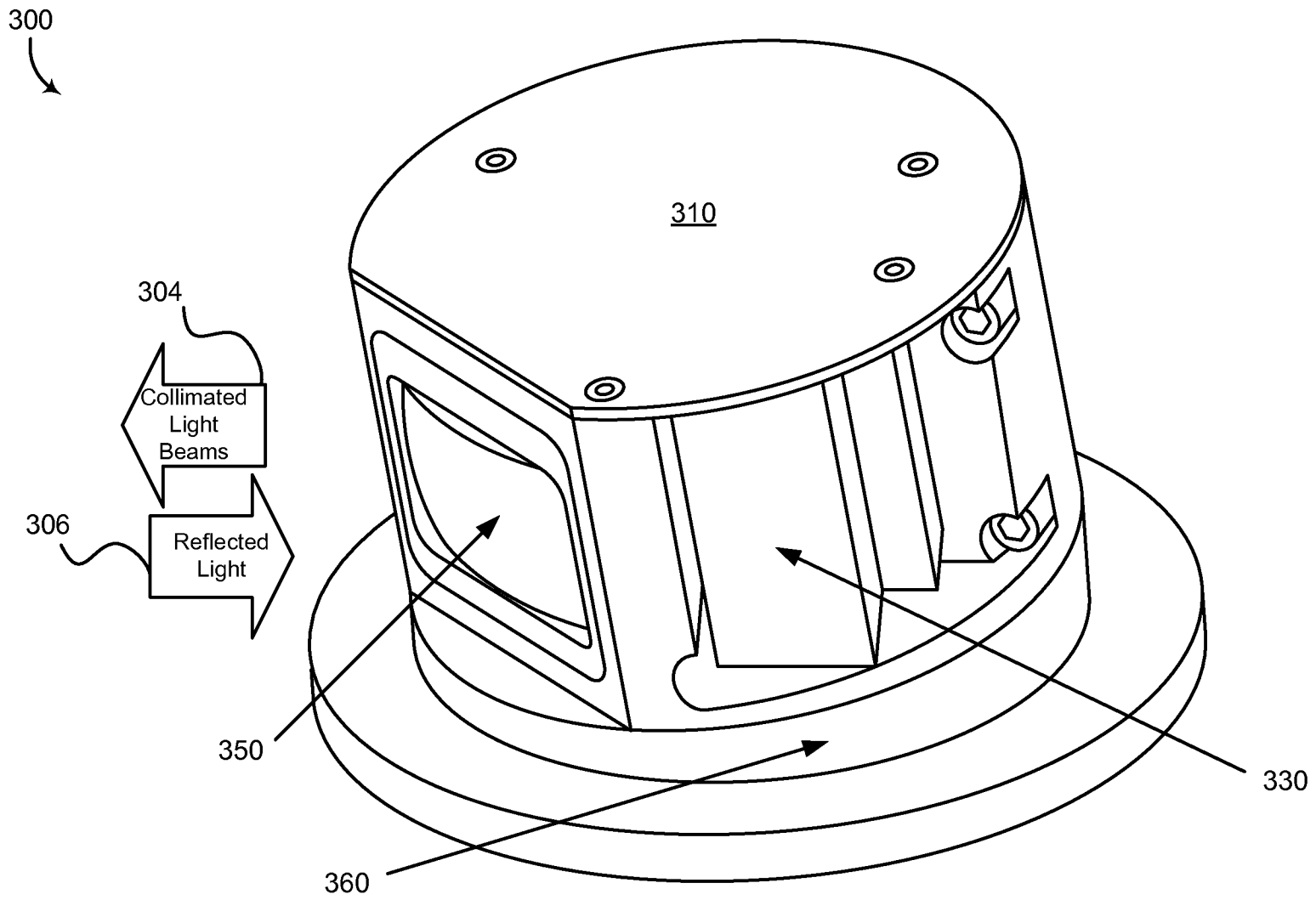

300
310
304
Collimated Light Beams
306
Reflected Light
350
330
360

FIG. 3A

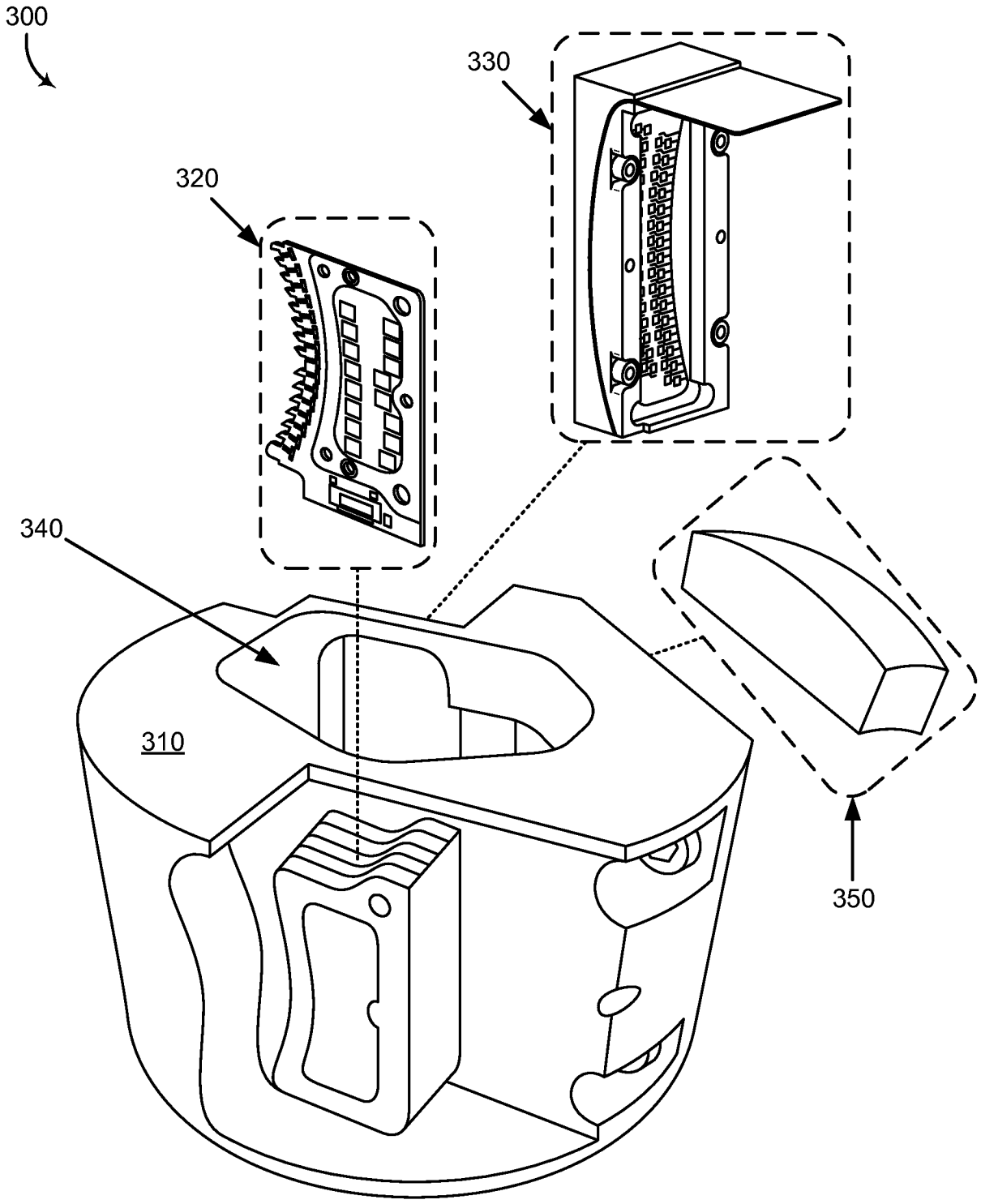


FIG. 3B

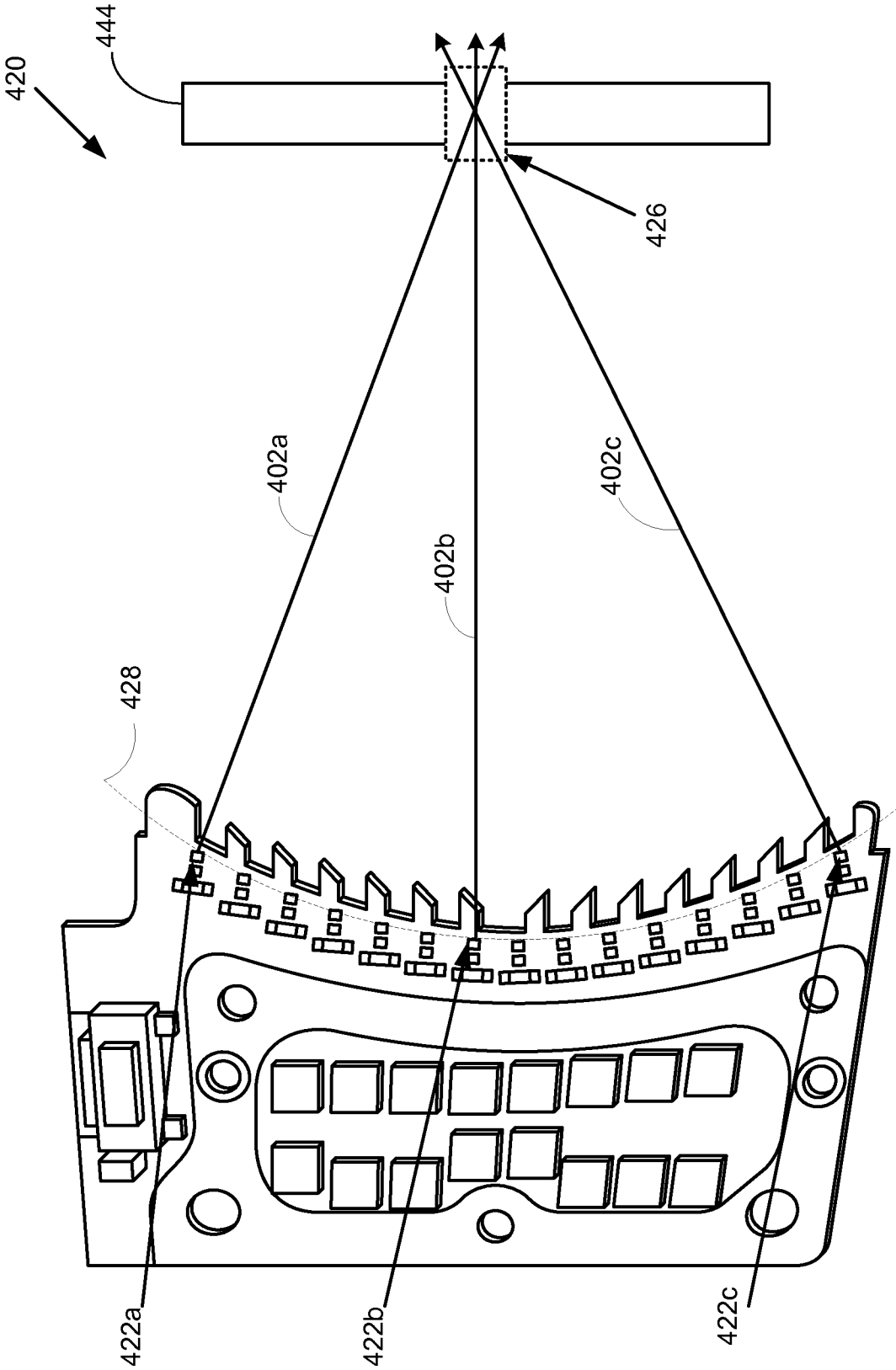


FIG. 4

FIG. 5A

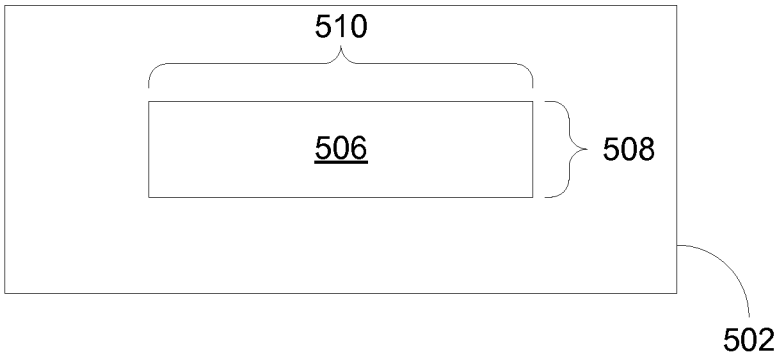


FIG. 5B

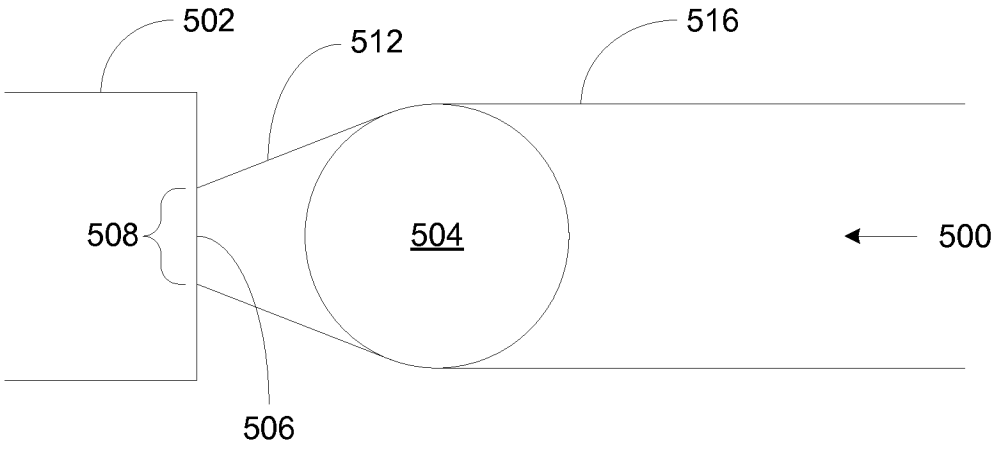
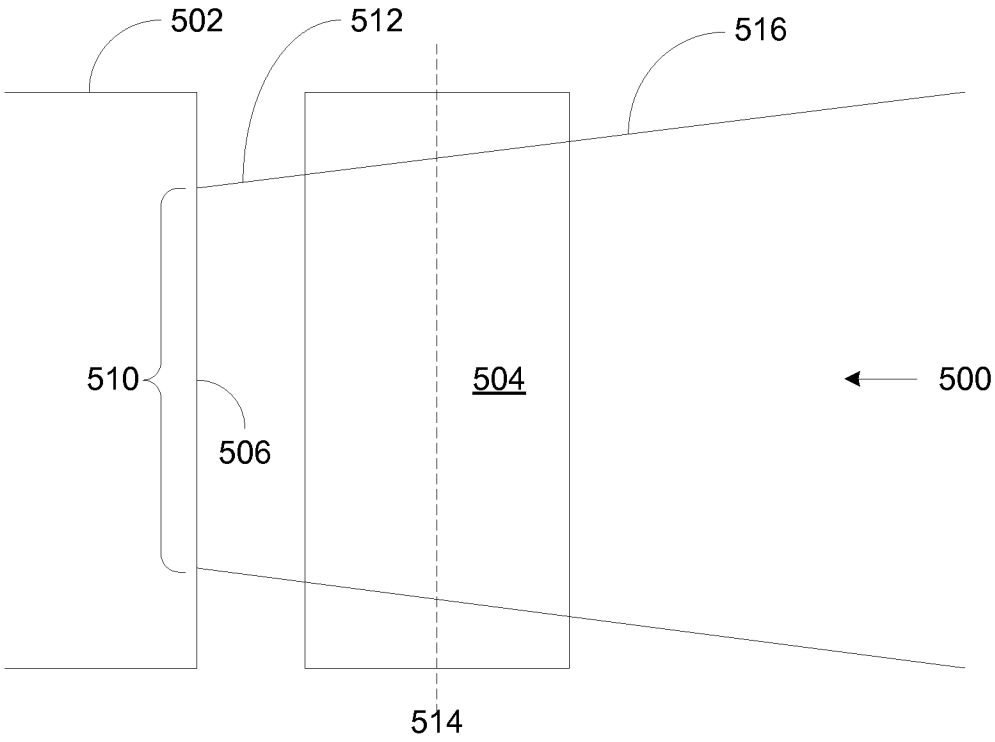


FIG. 5C



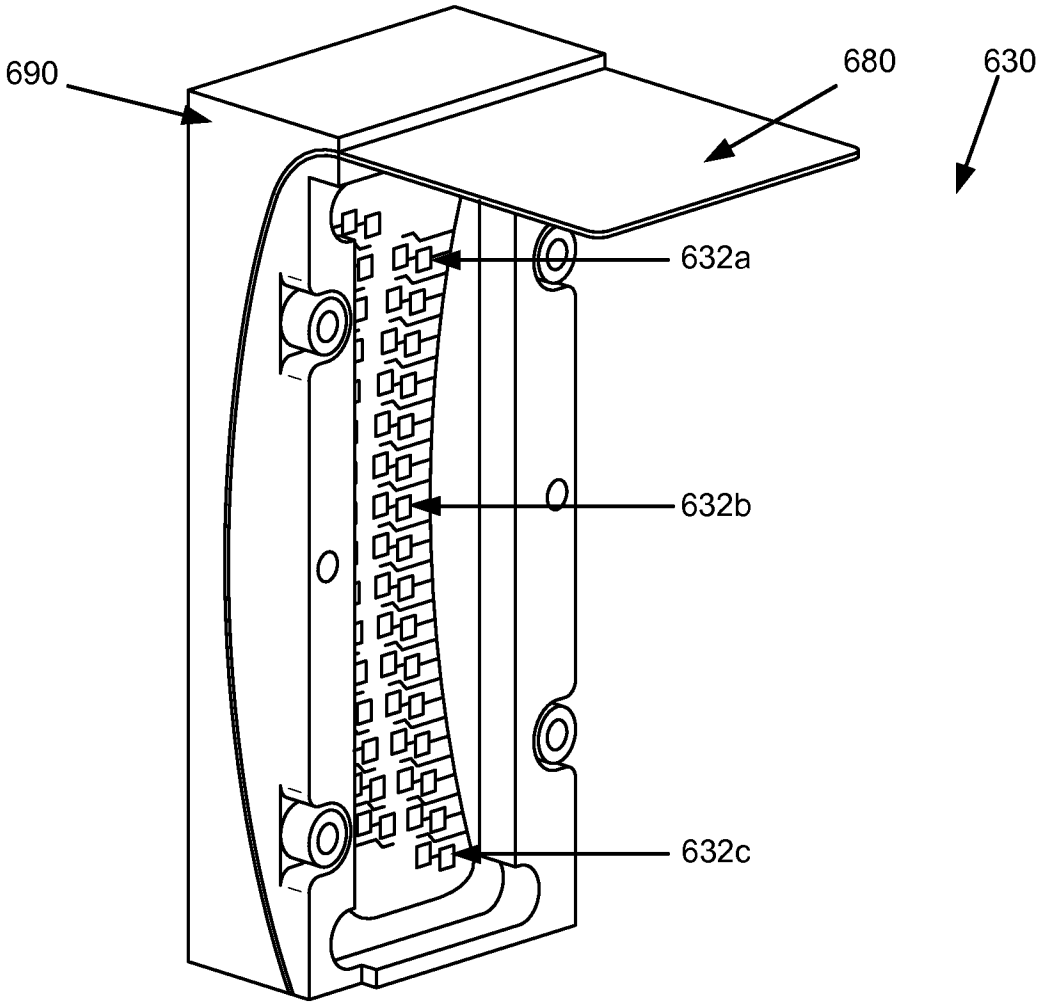

690
680
630
632a
632b
632c

FIG. 6A

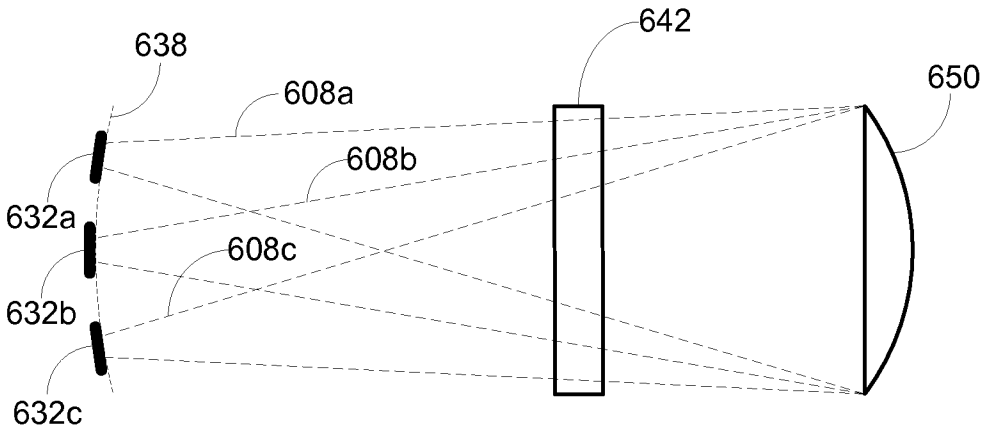

638
642
650
608a
608b
608c
632a
632b
632c

FIG. 6B

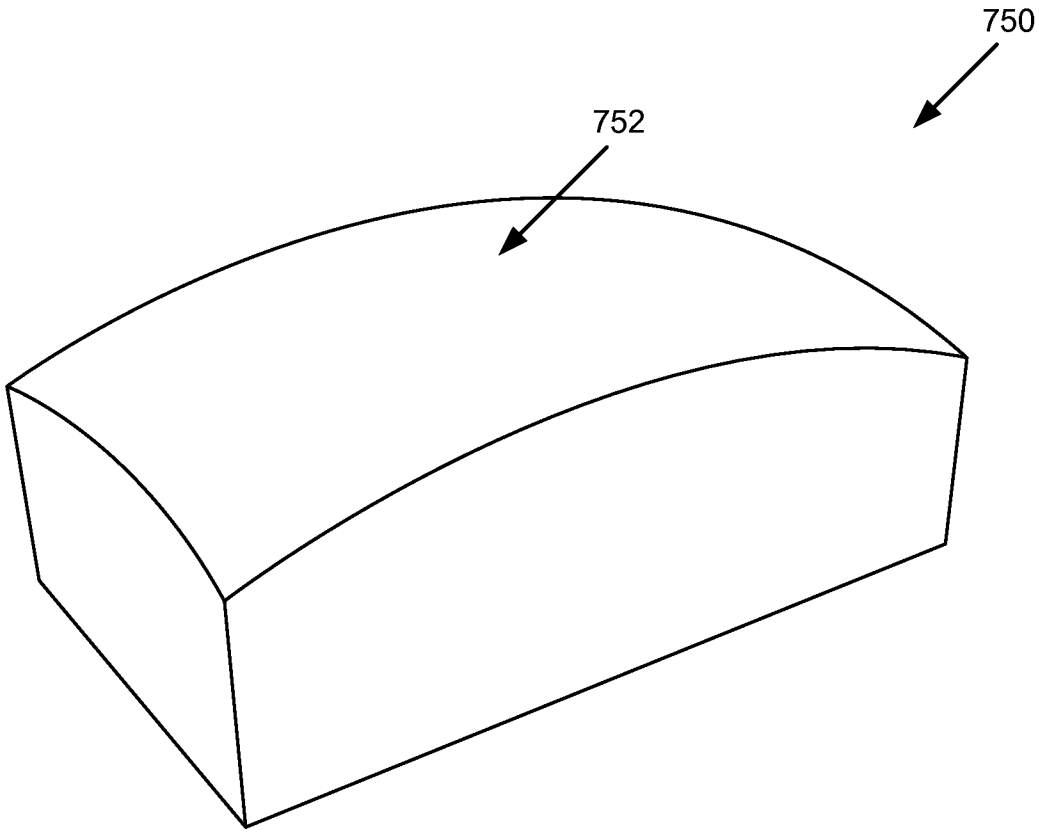


FIG. 7A

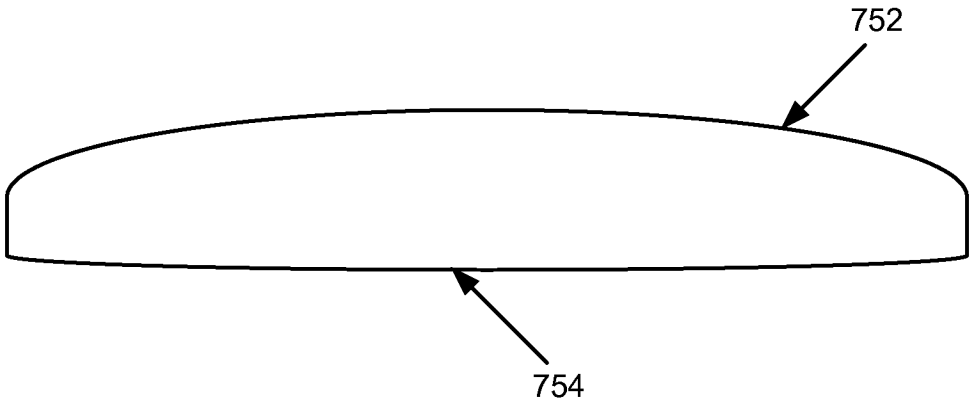
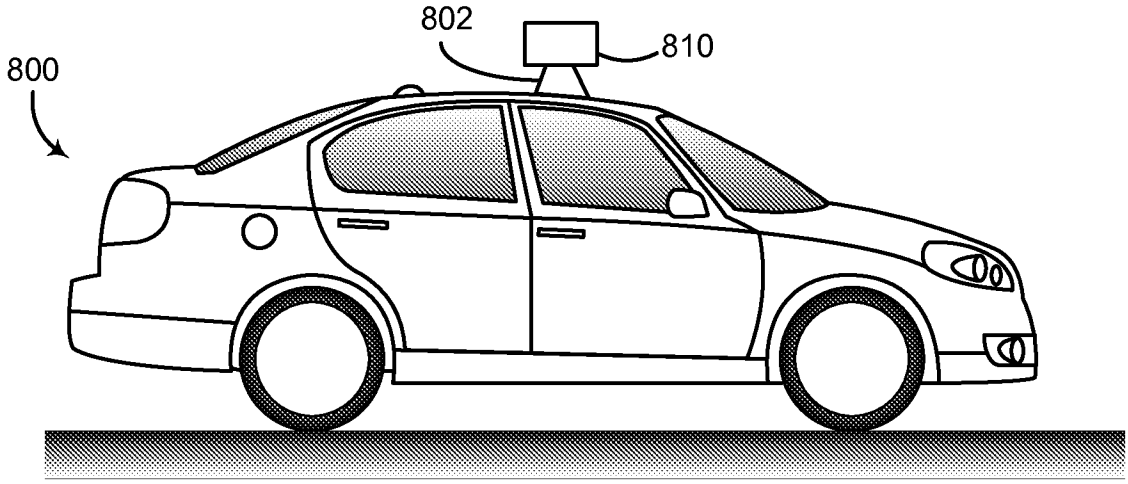
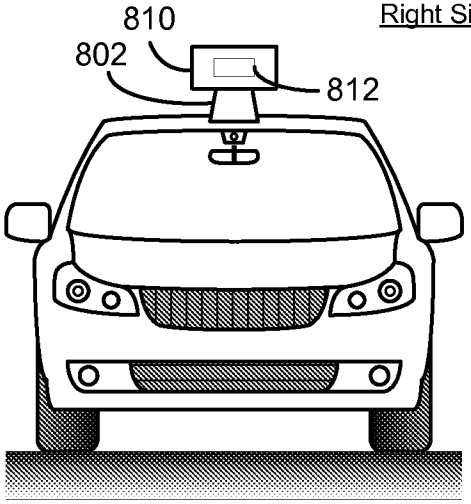


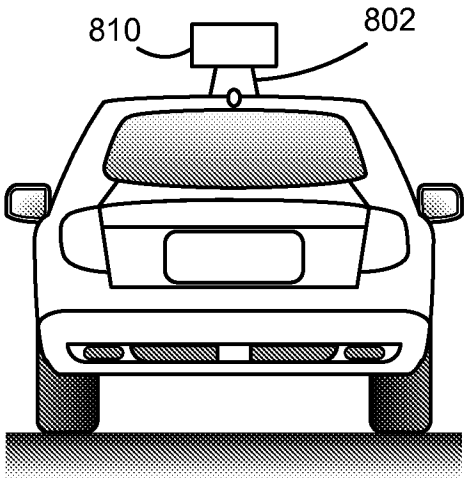
FIG. 7B



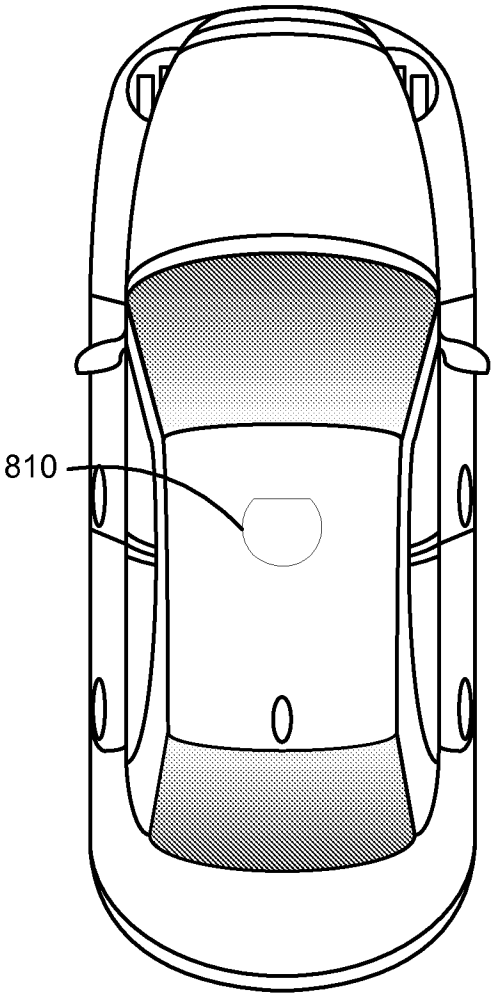
Right Side View



Front View



Back View



Top View

FIG. 8A

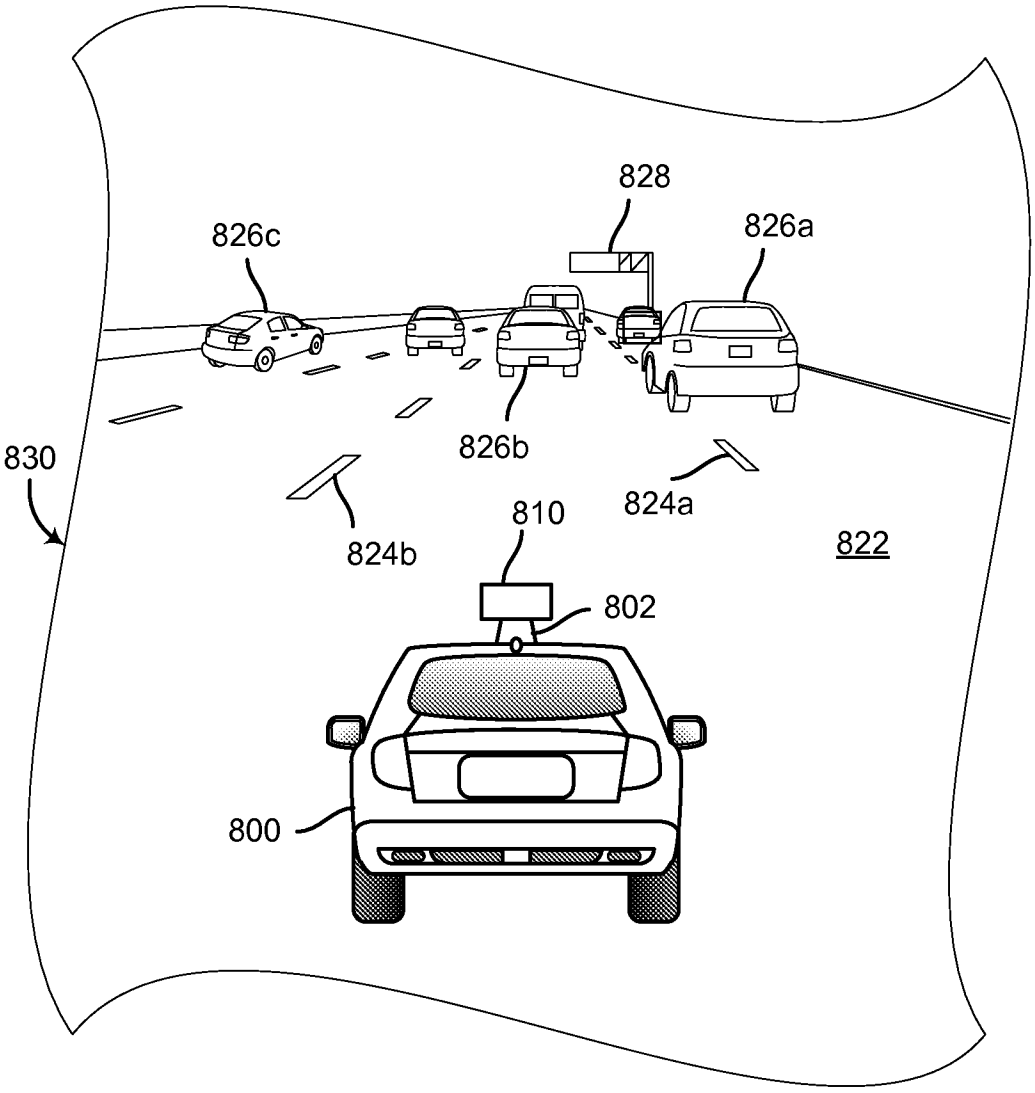


FIG. 8B

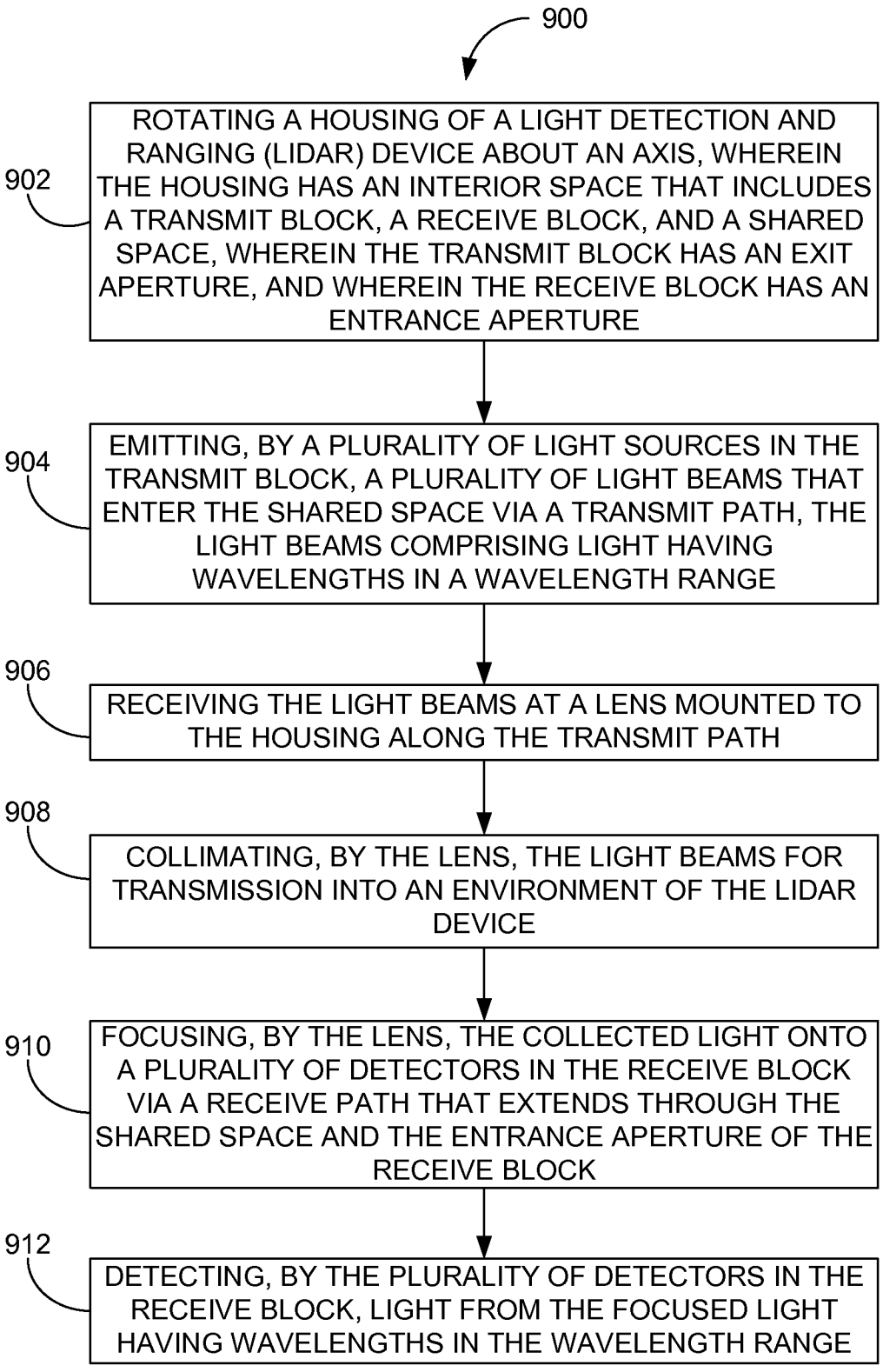

900
902
ROTATING A HOUSING OF A LIGHT DETECTION AND RANGING (LIDAR) DEVICE ABOUT AN AXIS, WHEREIN THE HOUSING HAS AN INTERIOR SPACE THAT INCLUDES A TRANSMIT BLOCK, A RECEIVE BLOCK, AND A SHARED SPACE, WHEREIN THE TRANSMIT BLOCK HAS AN EXIT APERTURE, AND WHEREIN THE RECEIVE BLOCK HAS AN ENTRANCE APERTURE
904
EMITTING, BY A PLURALITY OF LIGHT SOURCES IN THE TRANSMIT BLOCK, A PLURALITY OF LIGHT BEAMS THAT ENTER THE SHARED SPACE VIA A TRANSMIT PATH, THE LIGHT BEAMS COMPRISING LIGHT HAVING WAVELENGTHS IN A WAVELENGTH RANGE
906
RECEIVING THE LIGHT BEAMS AT A LENS MOUNTED TO THE HOUSING ALONG THE TRANSMIT PATH
908
COLLIMATING, BY THE LENS, THE LIGHT BEAMS FOR TRANSMISSION INTO AN ENVIRONMENT OF THE LIDAR DEVICE
910
FOCUSING, BY THE LENS, THE COLLECTED LIGHT ONTO A PLURALITY OF DETECTORS IN THE RECEIVE BLOCK VIA A RECEIVE PATH THAT EXTENDS THROUGH THE SHARED SPACE AND THE ENTRANCE APERTURE OF THE RECEIVE BLOCK
912
DETECTING, BY THE PLURALITY OF DETECTORS IN THE RECEIVE BLOCK, LIGHT FROM THE FOCUSED LIGHT HAVING WAVELENGTHS IN THE WAVELENGTH RANGE

Figure 9

DocCode - SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 13971606 Document Date: 08/20/2013

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

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